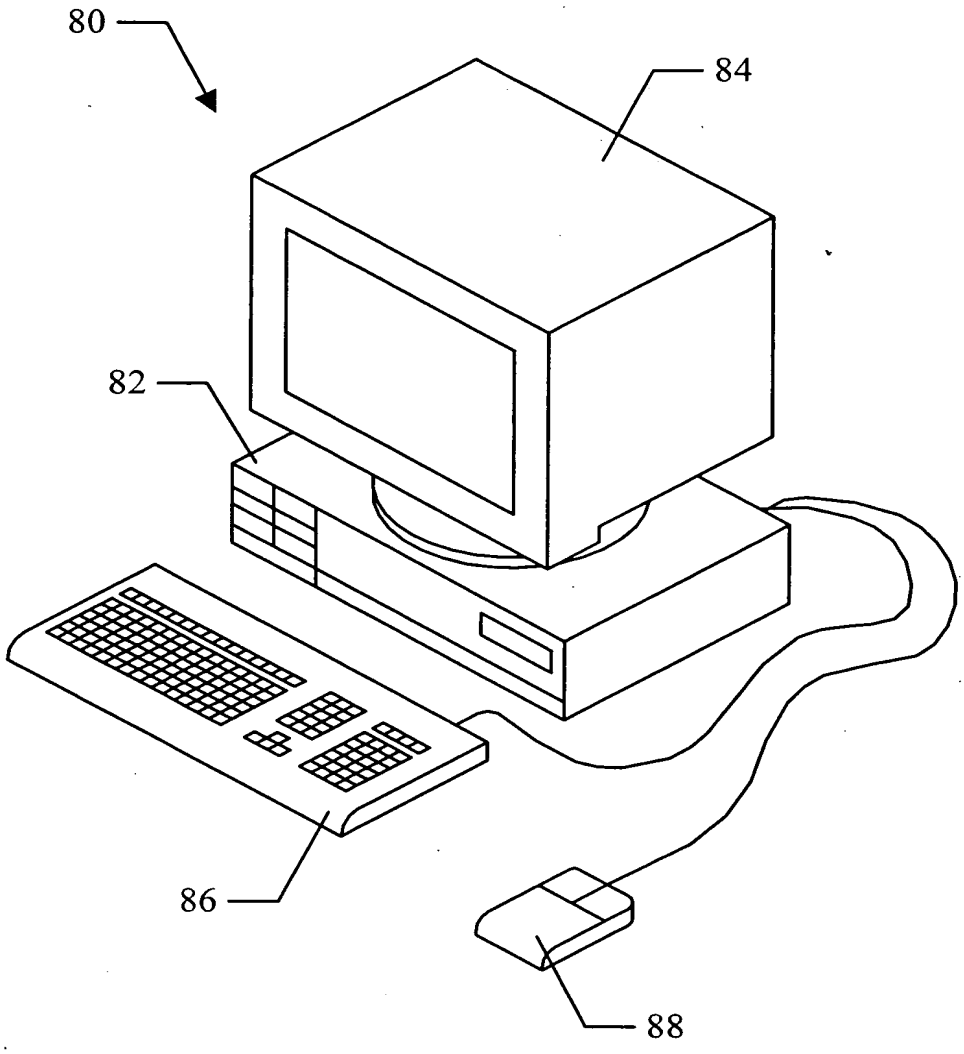


FIG. 1

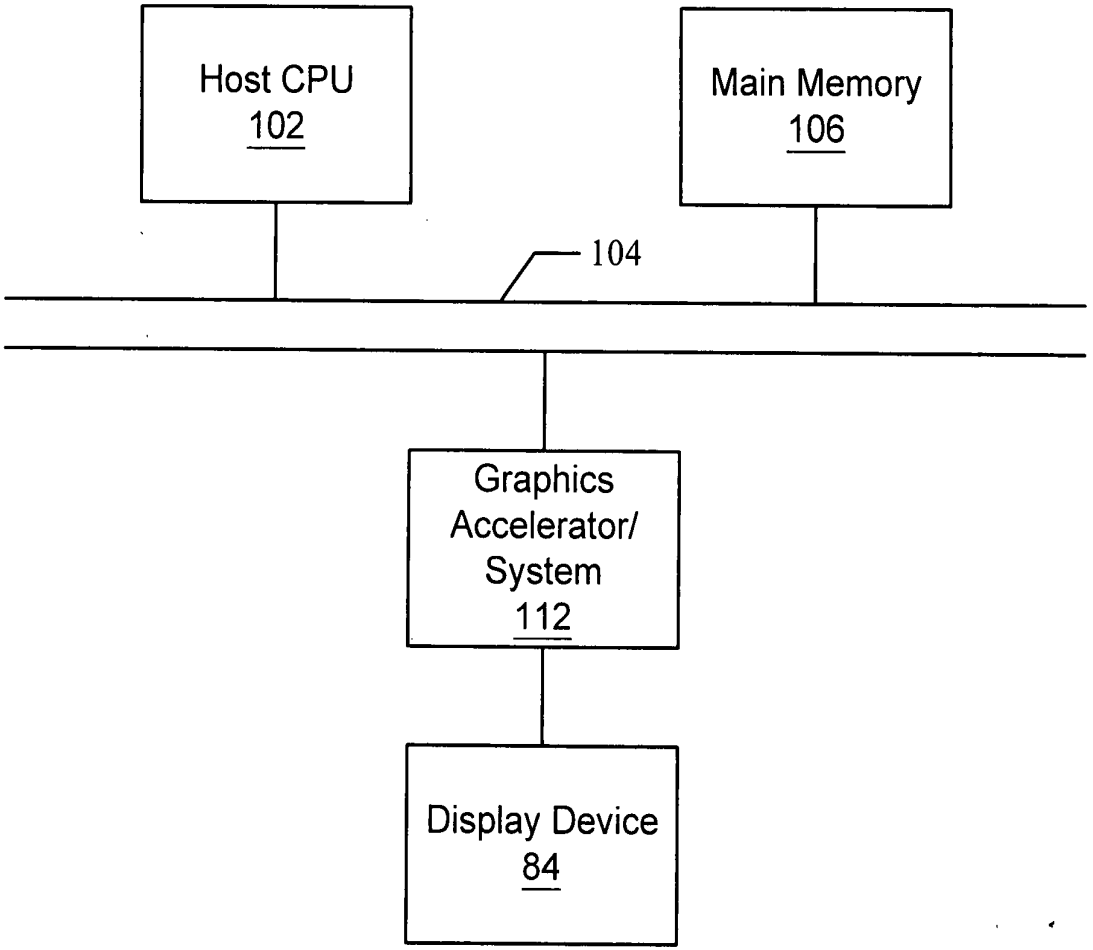

Host CPU
102
Main Memory
106
104
Graphics
Accelerator/
System
112
Display Device
84

FIG. 2

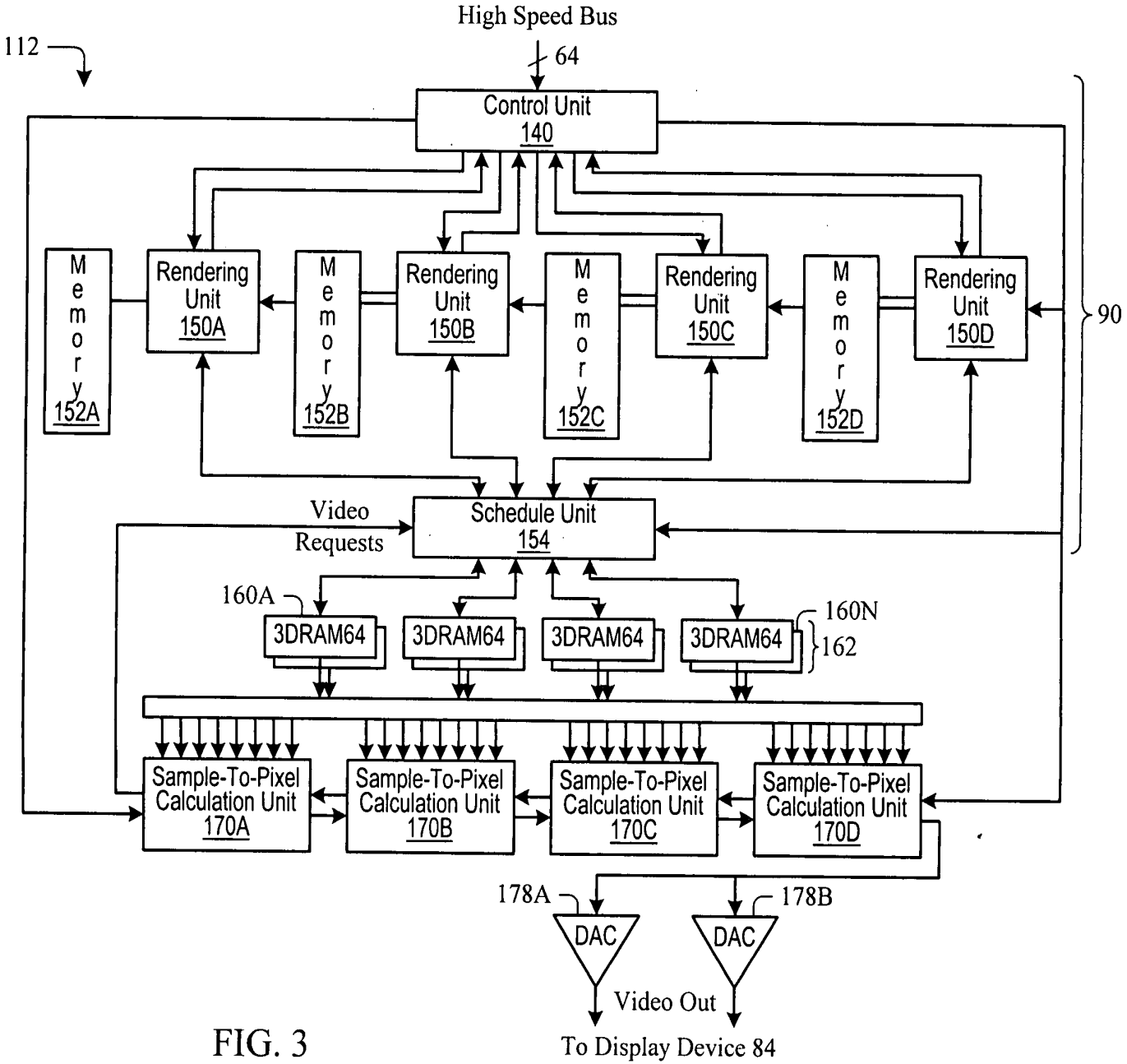

High Speed Bus
64
112
Control Unit
140
Memory
152A
Rendering
Unit
150A
Memory
152B
Rendering
Unit
150B
Memory
152C
Rendering
Unit
150C
Memory
152D
Rendering
Unit
150D
90
Video
Requests
Schedule Unit
154
160A
3DRAM64
3DRAM64
3DRAM64
3DRAM64
160N
162
Sample-To-Pixel
Calculation Unit
170A
Sample-To-Pixel
Calculation Unit
170B
Sample-To-Pixel
Calculation Unit
170C
Sample-To-Pixel
Calculation Unit
170D
178A
178B
DAC
DAC
Video Out
To Display Device 84

FIG. 3

DOCKET ALARM

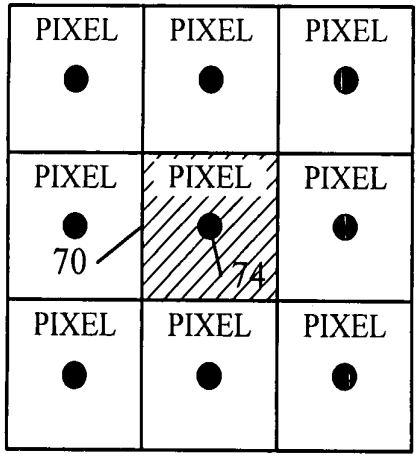


FIG. 4

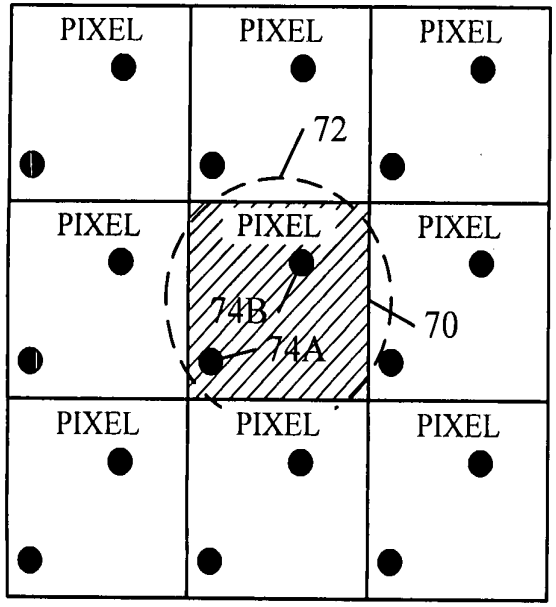


FIG. 5A

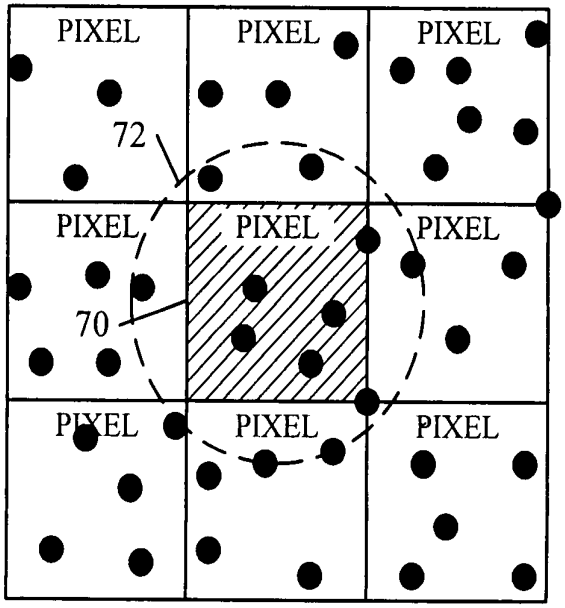


FIG. 5B

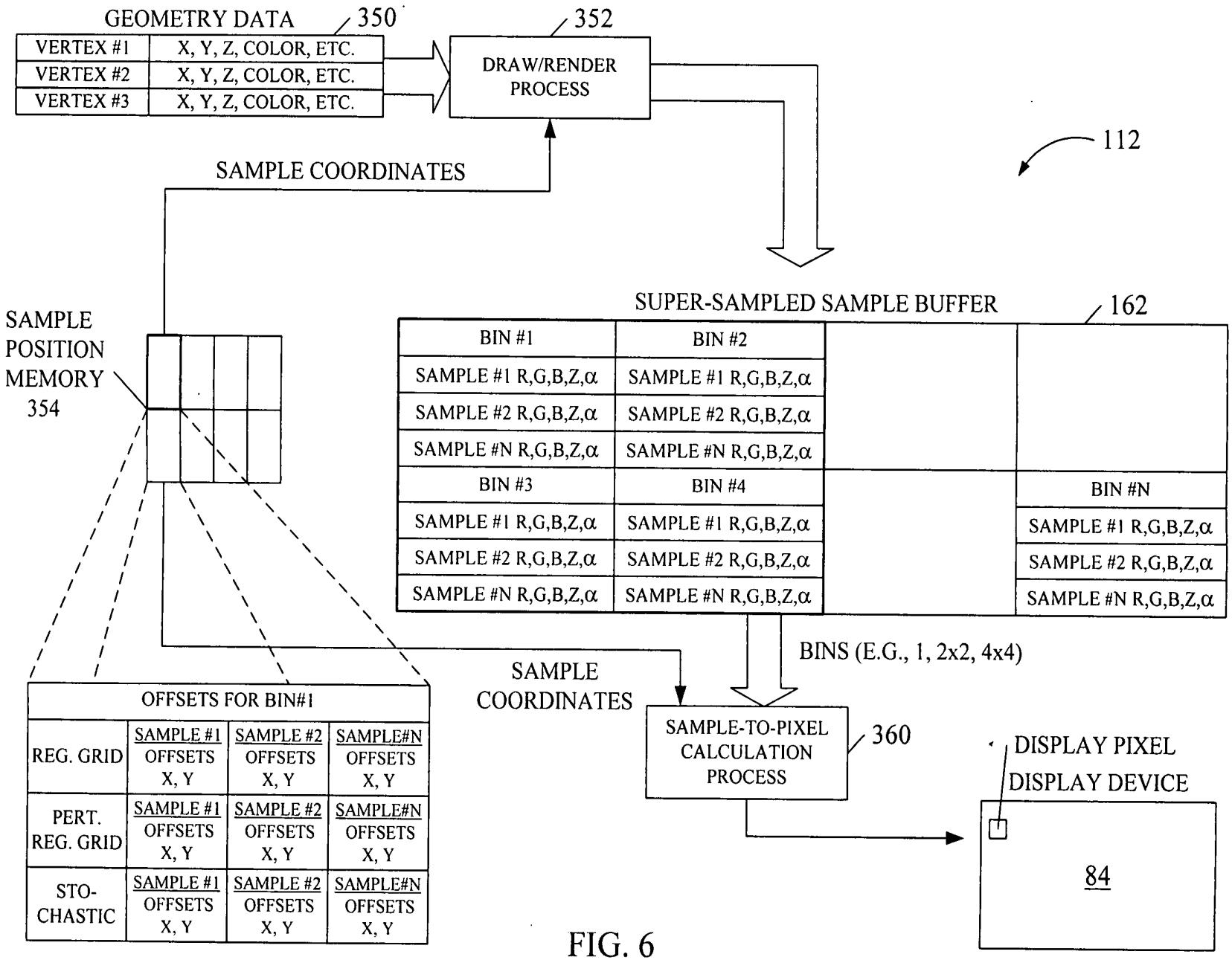

GEOMETRY DATA
350
VERTEX #1
X, Y, Z, COLOR, ETC.
VERTEX #2
X, Y, Z, COLOR, ETC.
VERTEX #3
X, Y, Z, COLOR, ETC.
352
DRAW/RENDER PROCESS
112
SAMPLE COORDINATES
SUPER-SAMPLED SAMPLE BUFFER
162
SAMPLE POSITION MEMORY 354
BIN #1
BIN #2
SAMPLE #1 R,G,B,Z,α
SAMPLE #2 R,G,B,Z,α
SAMPLE #N R,G,B,Z,α
BIN #3
BIN #4
BIN #N
BINS (E.G., 1, 2x2, 4x4)
SAMPLE COORDINATES
OFFSETS FOR BIN#1
REG. GRID
PERT. REG. GRID
STO-CHASTIC
SAMPLE #1 OFFSETS X, Y
SAMPLE #2 OFFSETS X, Y
SAMPLE#N OFFSETS X, Y
SAMPLE-TO-PIXEL CALCULATION PROCESS
360
DISPLAY PIXEL
DISPLAY DEVICE
84

FIG. 6

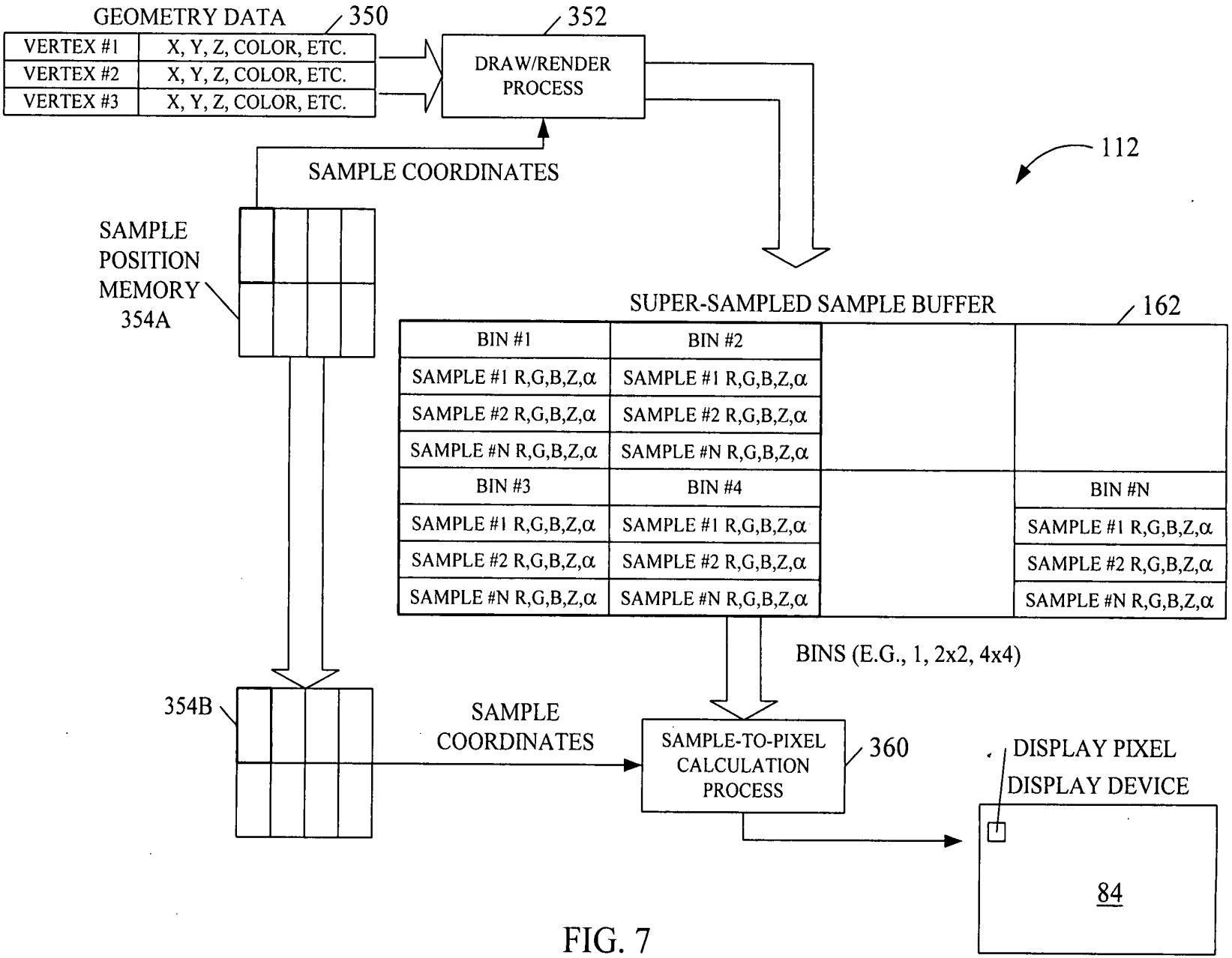
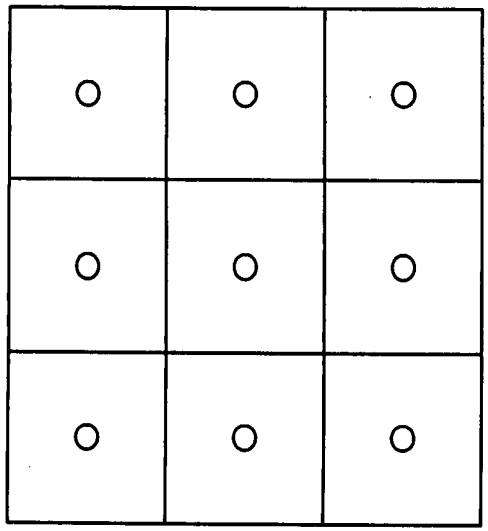
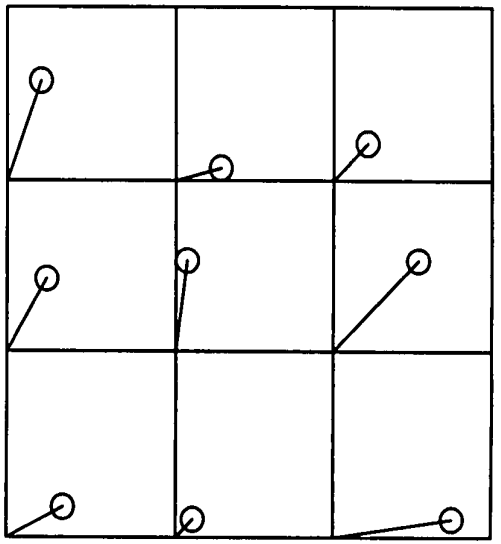

GEOMETRY DATA
350
VERTEX #1
X, Y, Z, COLOR, ETC.
VERTEX #2
X, Y, Z, COLOR, ETC.
VERTEX #3
X, Y, Z, COLOR, ETC.
352
DRAW/RENDER PROCESS
112
SAMPLE COORDINATES
SAMPLE POSITION MEMORY 354A
SUPER-SAMPLED SAMPLE BUFFER
162
BIN #1
BIN #2
SAMPLE #1 R,G,B,Z,α
SAMPLE #2 R,G,B,Z,α
SAMPLE #N R,G,B,Z,α
BIN #3
BIN #4
BIN #N
BINS (E.G., 1, 2x2, 4x4)
354B
SAMPLE COORDINATES
SAMPLE-TO-PIXEL CALCULATION PROCESS
360
DISPLAY PIXEL
DISPLAY DEVICE
84

FIG. 7

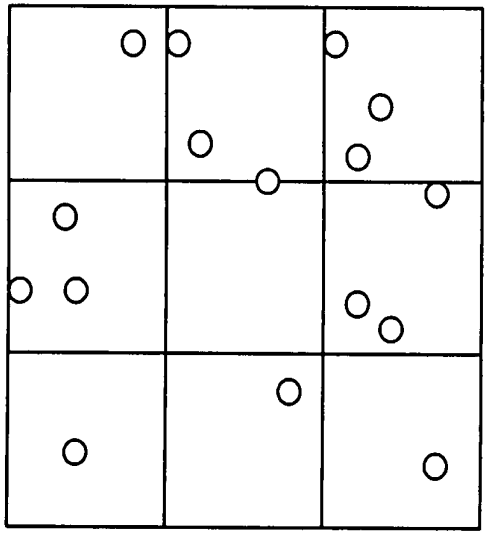
DOCKET: 2378.020



REGULAR GRID 190



192 PERTURBED REGULAR GRID



194 STOCHASTIC SPACING

FIG. 8

DOCKET 2737/200

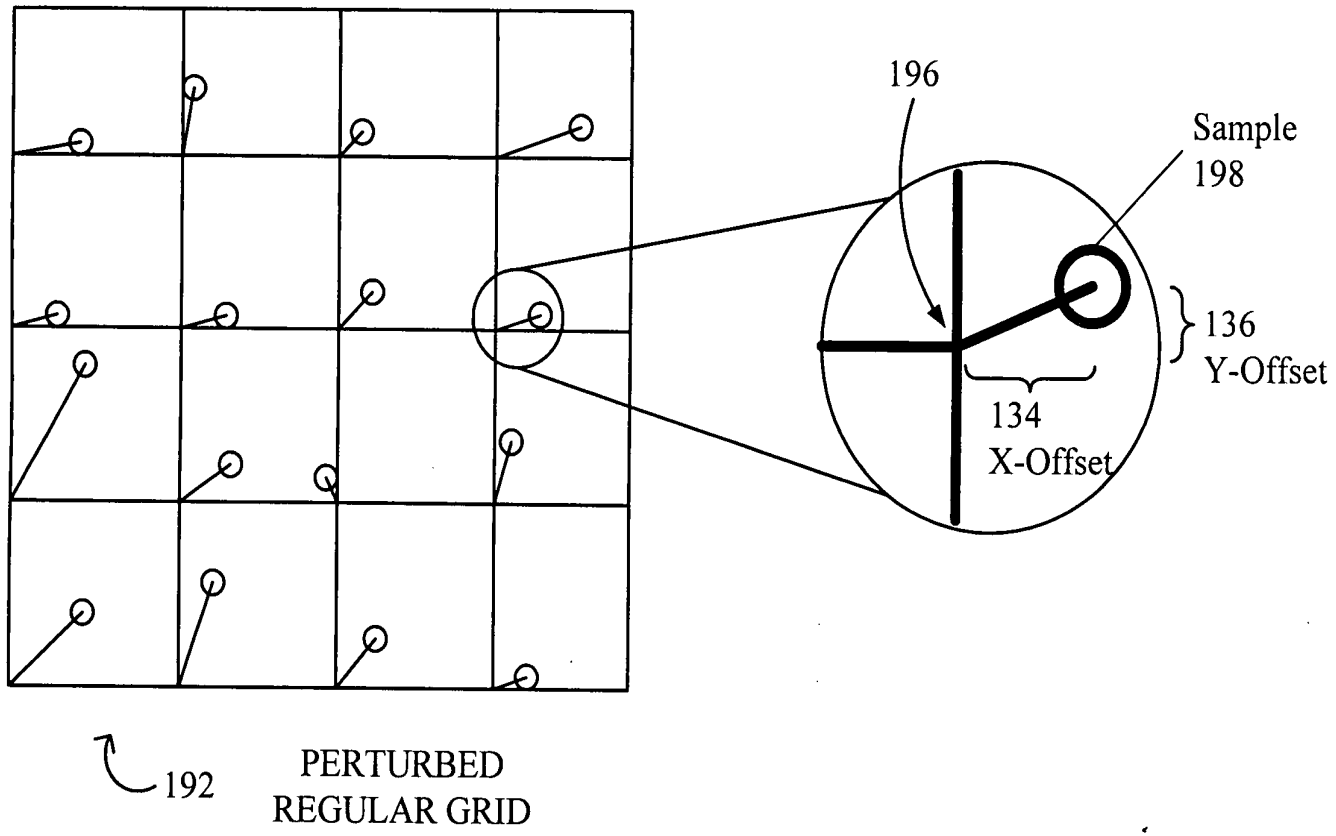


FIG. 9

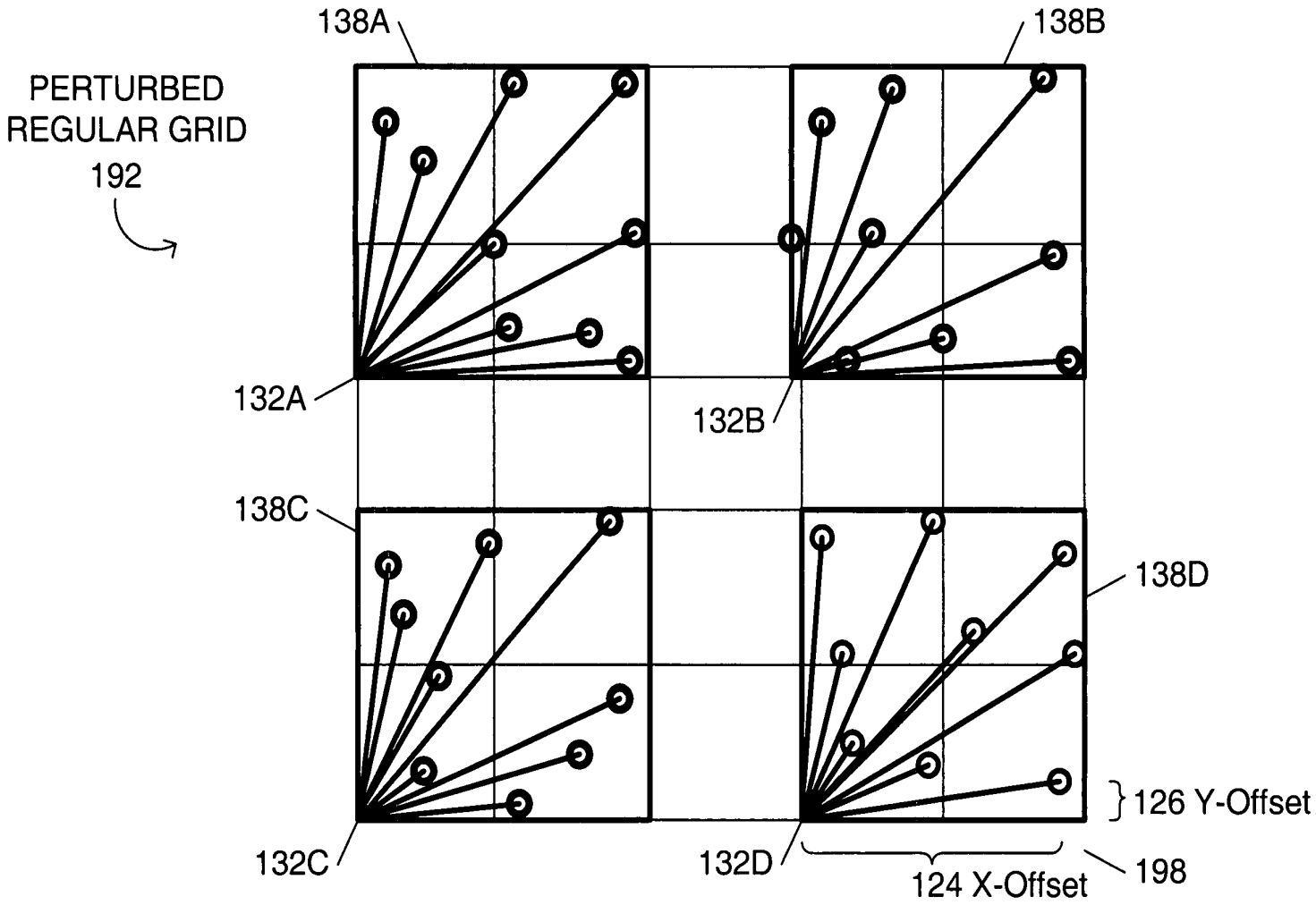

PERTURBED
REGULAR GRID
192
138A
138B
132A
132B
138C
138D
126 Y-Offset
132C
132D
124 X-Offset
198

FIG. 10

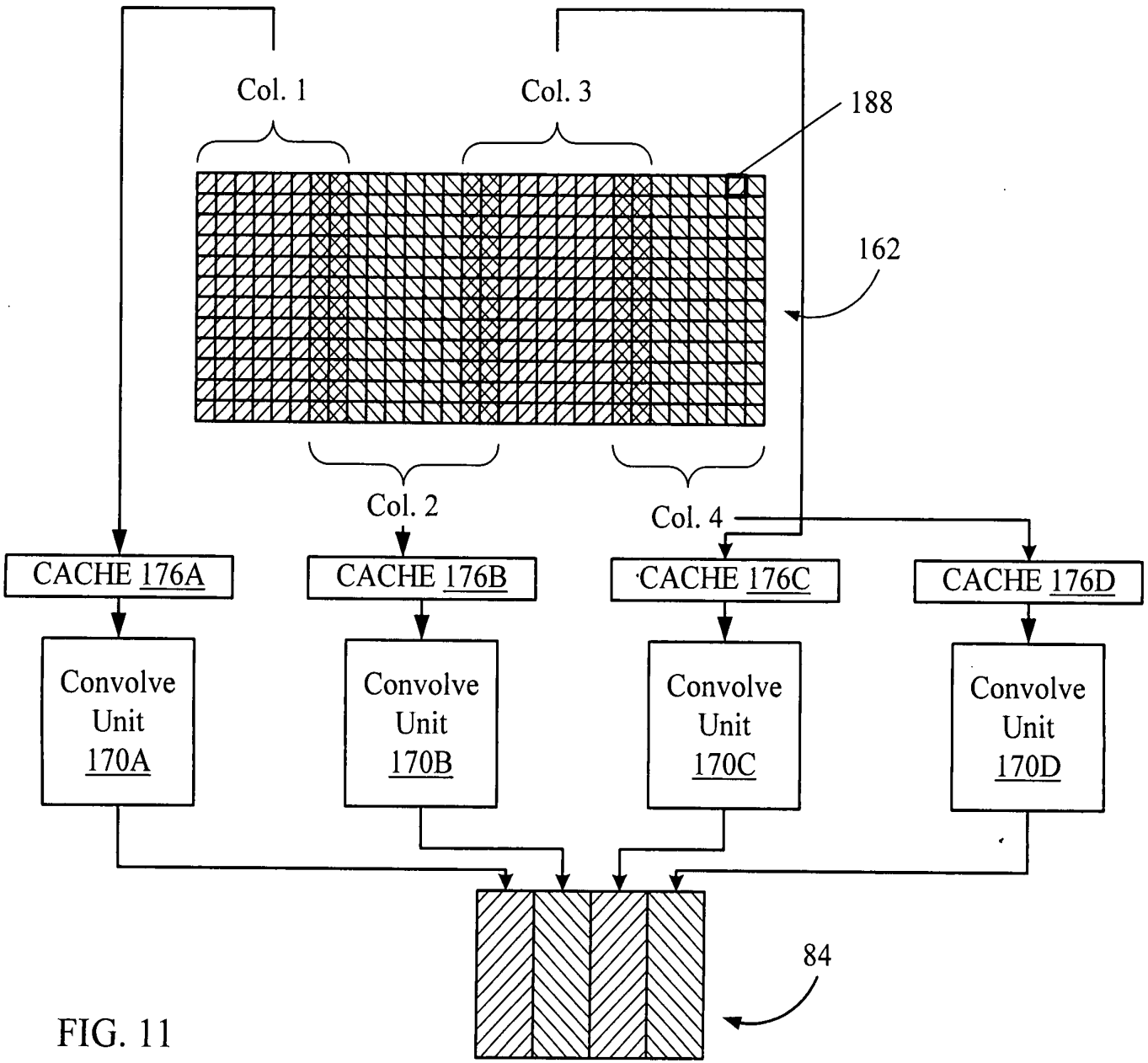

Col. 1
Col. 3
188
162
Col. 2
Col. 4
CACHE 176A
CACHE 176B
CACHE 176C
CACHE 176D
Convolve Unit 170A
Convolve Unit 170B
Convolve Unit 170C
Convolve Unit 170D
84

FIG. 11

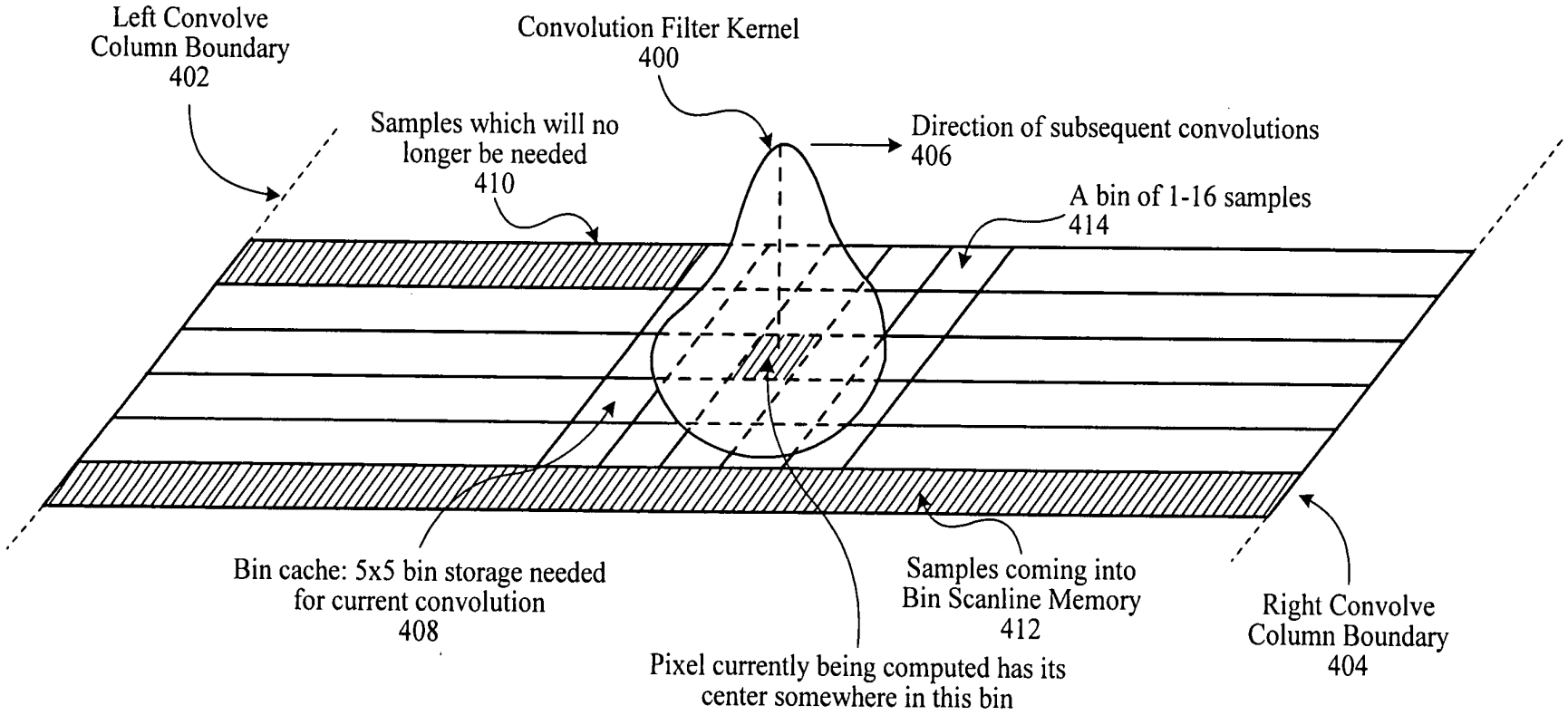

Left Convolve
Column Boundary
402
Convolution Filter Kernel
400
Samples which will no
longer be needed
410
Direction of subsequent convolutions
406
A bin of 1-16 samples
414
Bin cache: 5x5 bin storage needed
for current convolution
408
Samples coming into
Bin Scanline Memory
412
Right Convolve
Column Boundary
404
Pixel currently being computed has its
center somewhere in this bin

FIG. 11A

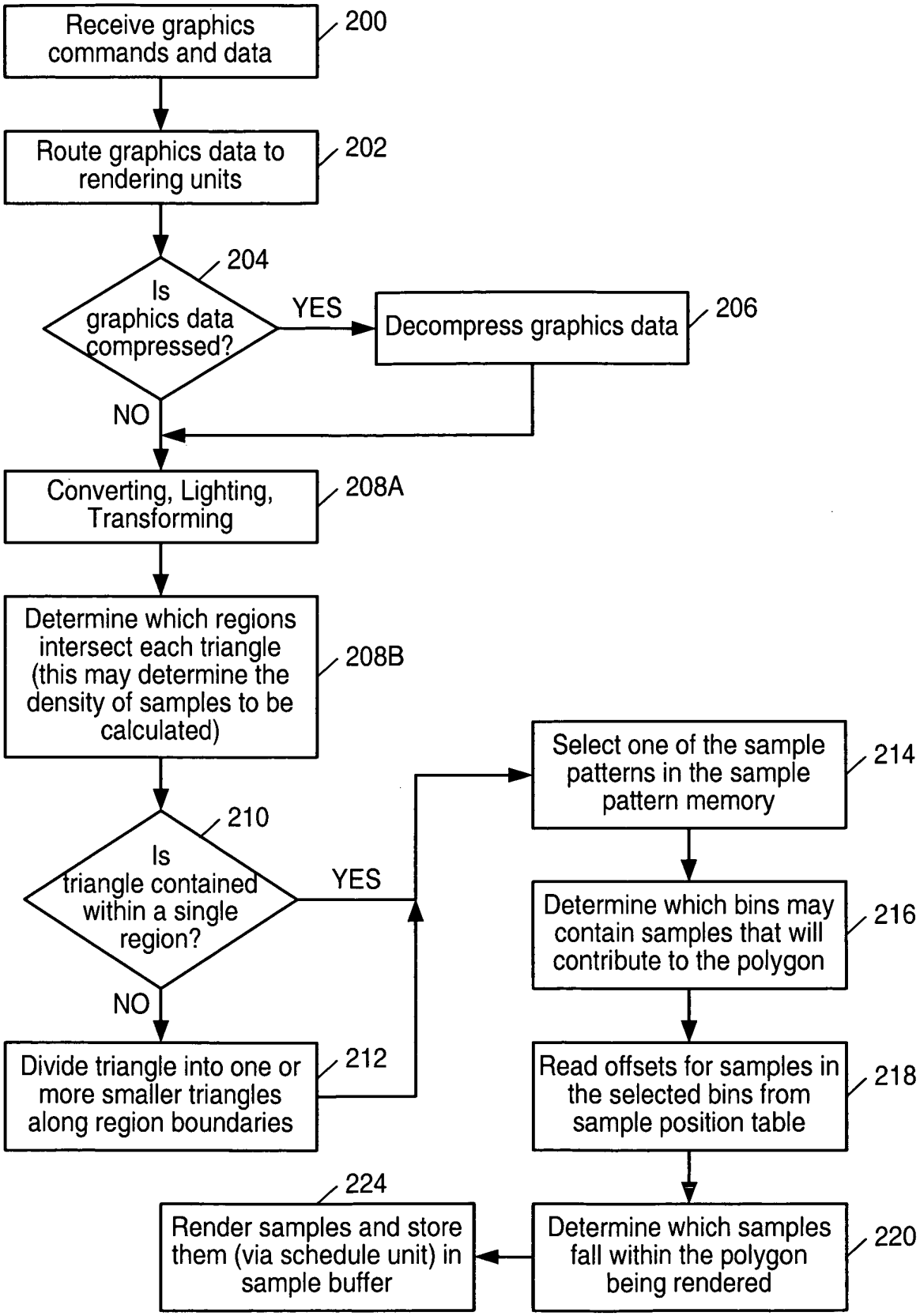

Receive graphics commands and data
200
Route graphics data to rendering units
202
204
Is graphics data compressed?
YES
Decompress graphics data
206
NO
Converting, Lighting, Transforming
208A
Determine which regions intersect each triangle (this may determine the density of samples to be calculated)
208B
210
Is triangle contained within a single region?
YES
NO
Divide triangle into one or more smaller triangles along region boundaries
212
Select one of the sample patterns in the sample pattern memory
214
Determine which bins may contain samples that will contribute to the polygon
216
Read offsets for samples in the selected bins from sample position table
218
Determine which samples fall within the polygon being rendered
220
224
Render samples and store them (via schedule unit) in sample buffer

FIG. 12

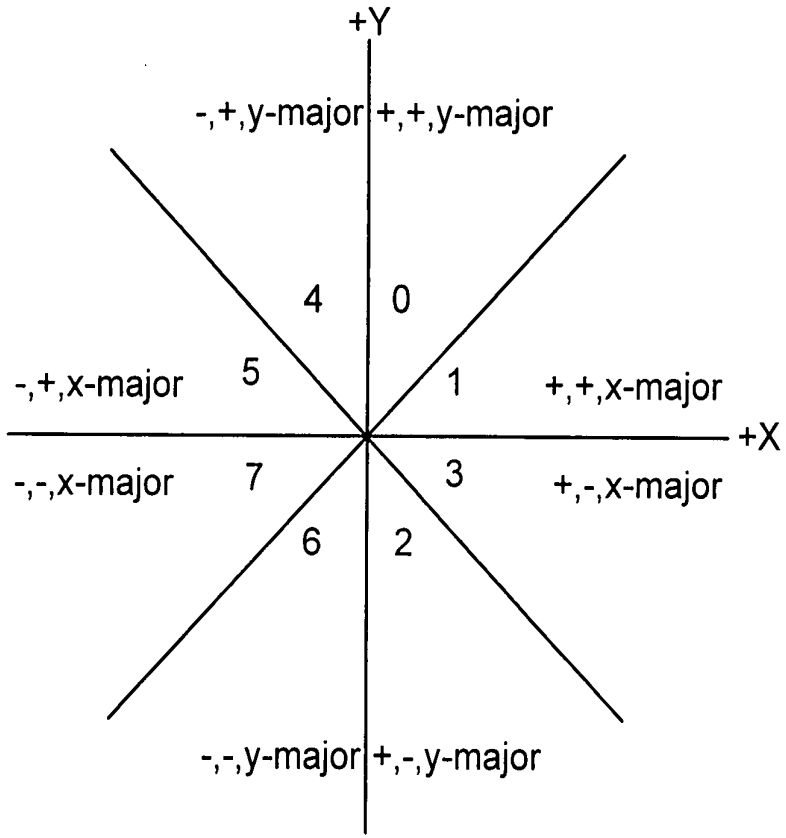

+Y
-,+,y-major
+,+,y-major
4
0
-,+,x-major
5
1
+,+,x-major
+X
-,-,x-major
7
3
+,-,x-major
6
2
-,-,y-major
+,-,y-major

FIG. 12A

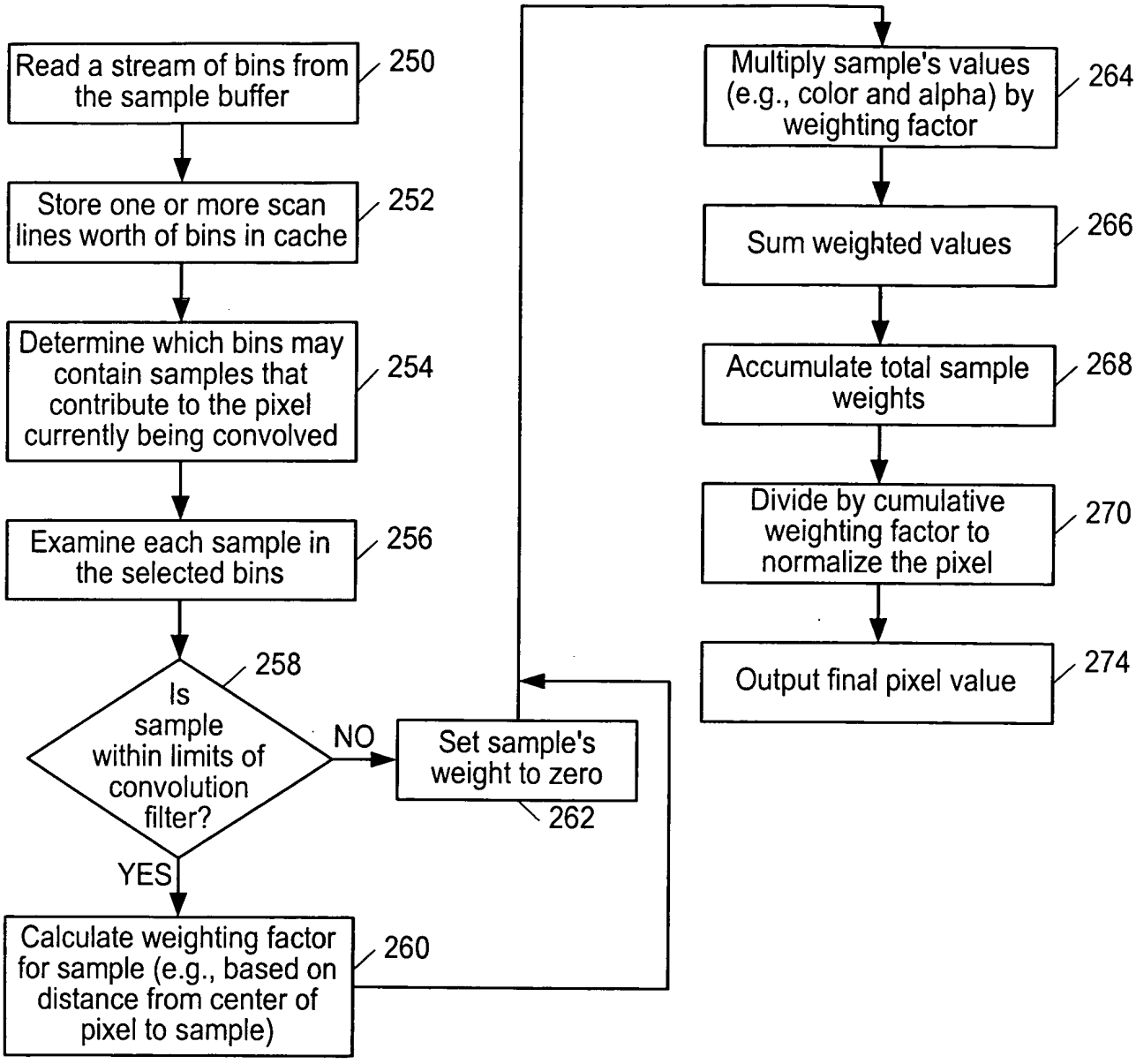
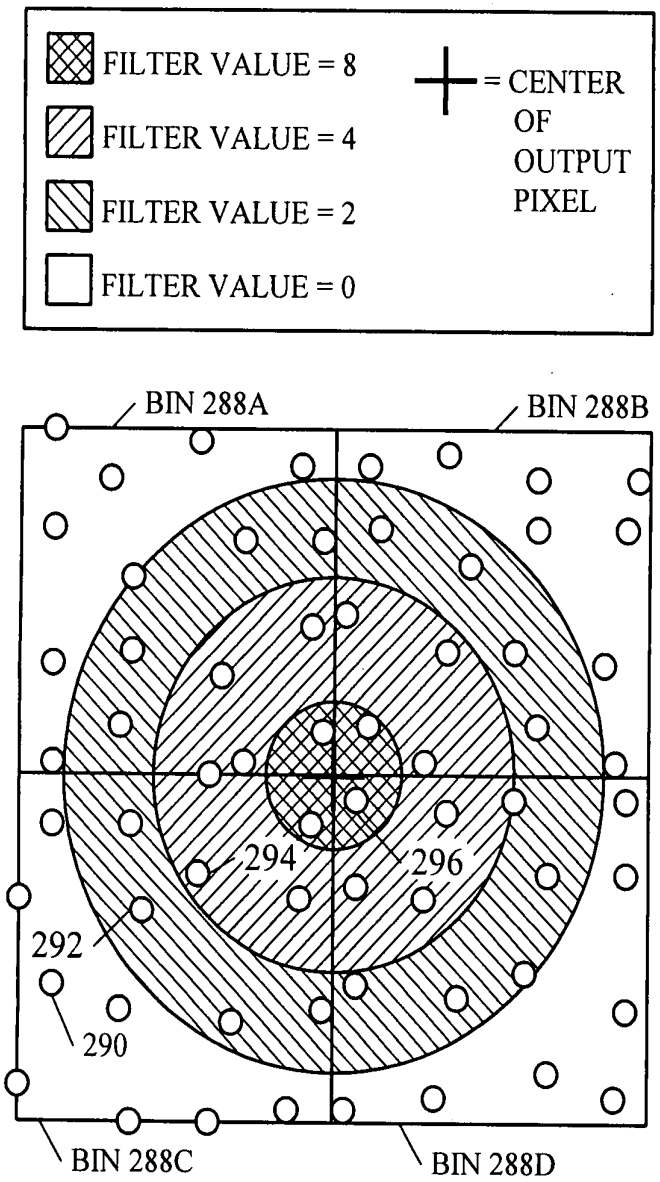

Read a stream of bins from the sample buffer
250
Store one or more scan lines worth of bins in cache
252
Determine which bins may contain samples that contribute to the pixel currently being convolved
254
Examine each sample in the selected bins
256
Is sample within limits of convolution filter?
258
NO
Set sample's weight to zero
262
YES
Calculate weighting factor for sample (e.g., based on distance from center of pixel to sample)
260
Multiply sample's values (e.g., color and alpha) by weighting factor
264
Sum weighted values
266
Accumulate total sample weights
268
Divide by cumulative weighting factor to normalize the pixel
270
Output final pixel value
274

FIG. 13



300

Sample 190

R = 120
G = 200
B = 40
A = 150

FILTER VALUE = 0

302

Sample 192

R = 140
G = 180
B = 50
A = 160

FILTER VALUE = 2

304

Sample 194

R = 150
G = 170
B = 50
A = 180

FILTER VALUE = 4

306

Sample 196

R = 140
G = 170
B = 60
A = 190

FILTER VALUE = 8

308

NORMALIZATION VALUE = 0+2+4+8 = 14

310

UNNORMALIZED OUTPUT PIXEL

R = 120*0
+140*2
+150*4
+140*8 = 2000

G = 200*0
+180*2
+170*4
+170*8 = 2400

B = 40*0
+50*2
+50*4
+60*8 = 780

A = 150*0
+160*2
+180*4
+190*8 = 2560

312

NORMALIZED OUTPUT PIXEL

R = 2000 / 14 = 142.9
G = 2400 / 14 = 171.4
B = 780 / 14 = 55.7
A = 2560 / 14 = 175.7

FIG. 14

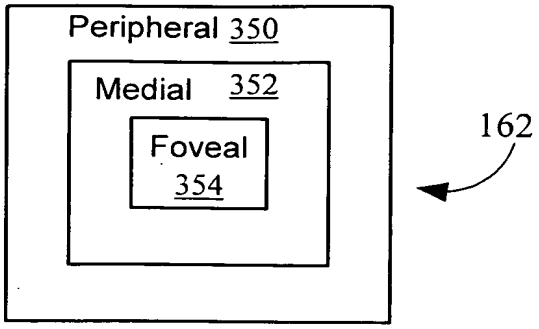


FIG. 15

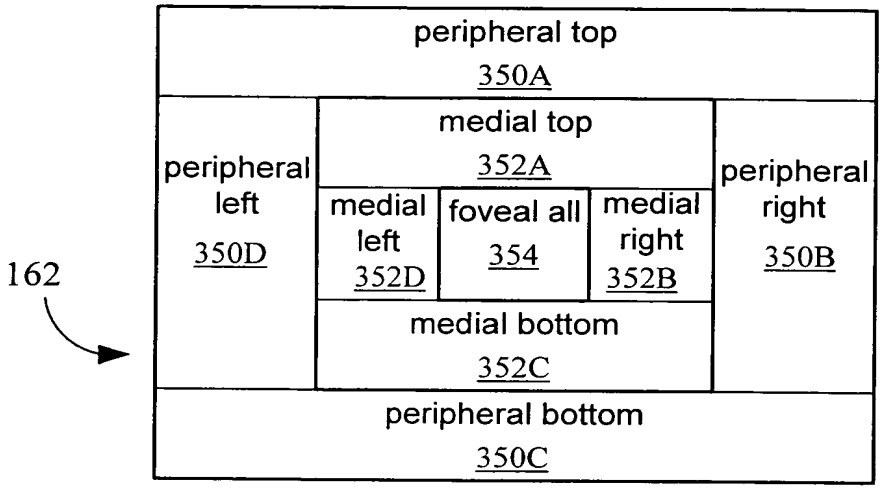


FIG. 16

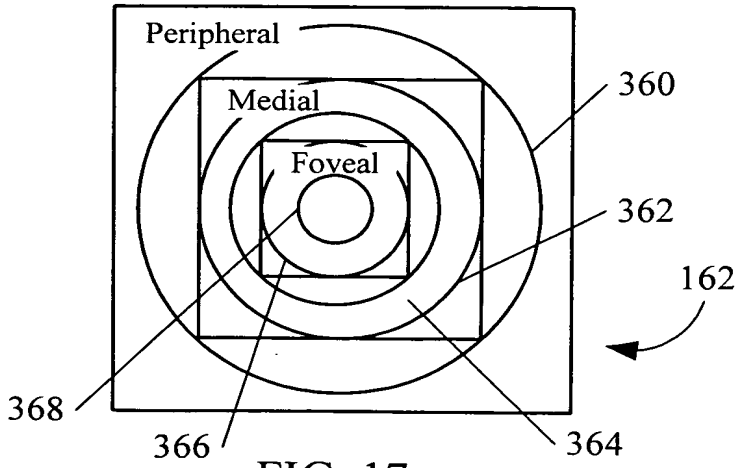
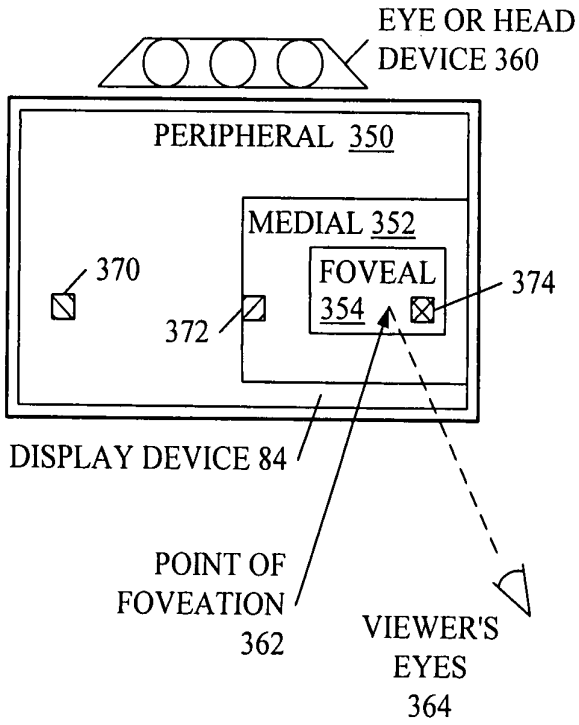
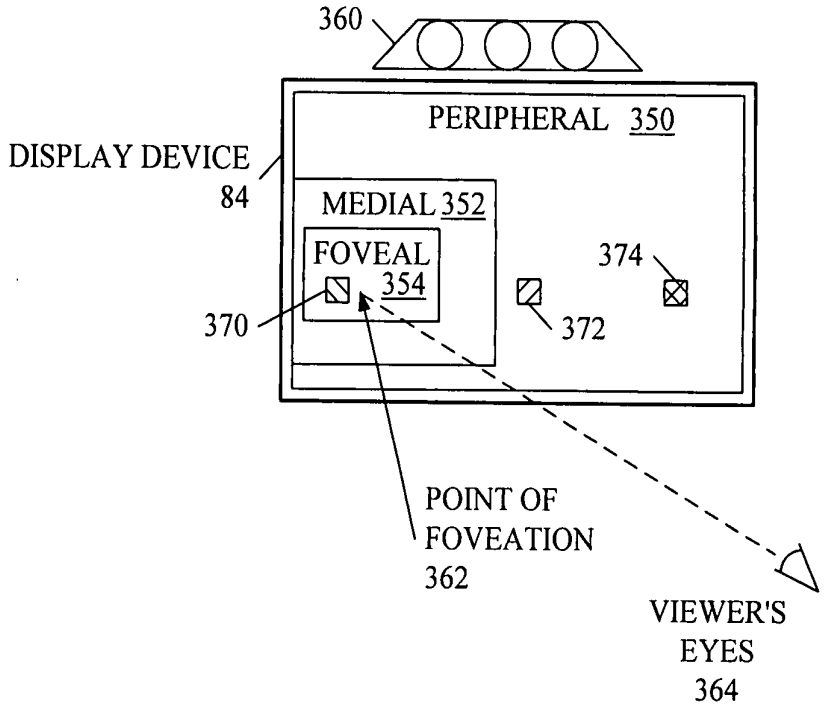


FIG. 17



- FOVEAL REGION = 8 SAMPLES PER BIN
  CONVOLUTION RADIUS TOUCHES 4 BINS
  TOTAL = 32 SAMPLES MAY CONTRIBUTE
- MEDIAL REGION = 4 SAMPLES PER BIN
  CONVOLUTION RADIUS TOUCHES 4 BINS
  TOTAL = 16 SAMPLES MAY CONTRIBUTE
- PERIPHERAL REGION = 1 SAMPLE PER BIN
  CONVOLUTION RADIUS TOUCHES 1 BIN
  TOTAL = 1 SAMPLE MAY CONTRIBUTE

FIG. 18A



- PERIPHERAL REGION = 1 SAMPLE PER BIN
  CONVOLUTION RADIUS TOUCHES 1 BIN
  TOTAL = 1 SAMPLE MAY CONTRIBUTE
- PERIPHERAL REGION = 1 SAMPLE PER BIN
  CONVOLUTION RADIUS TOUCHES 1 BINS
  TOTAL = 1 SAMPLE MAY CONTRIBUTE
- FOVEAL REGION = 8 SAMPLES PER BIN
  CONVOLUTION RADIUS TOUCHES 4 BIN
  TOTAL = 32 SAMPLE MAY CONTRIBUTE

FIG. 18B

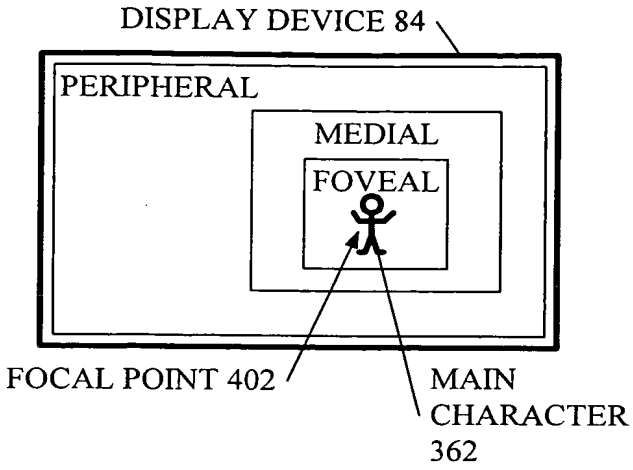


FIG. 19A

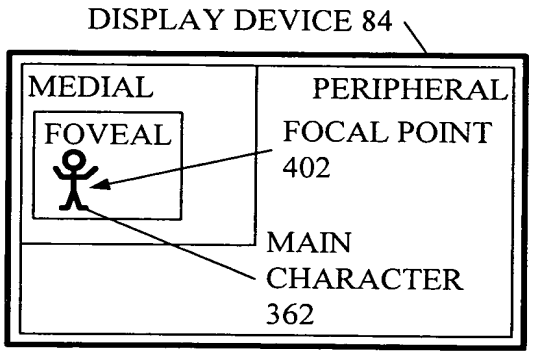


FIG. 19B

DOCKET EAST620

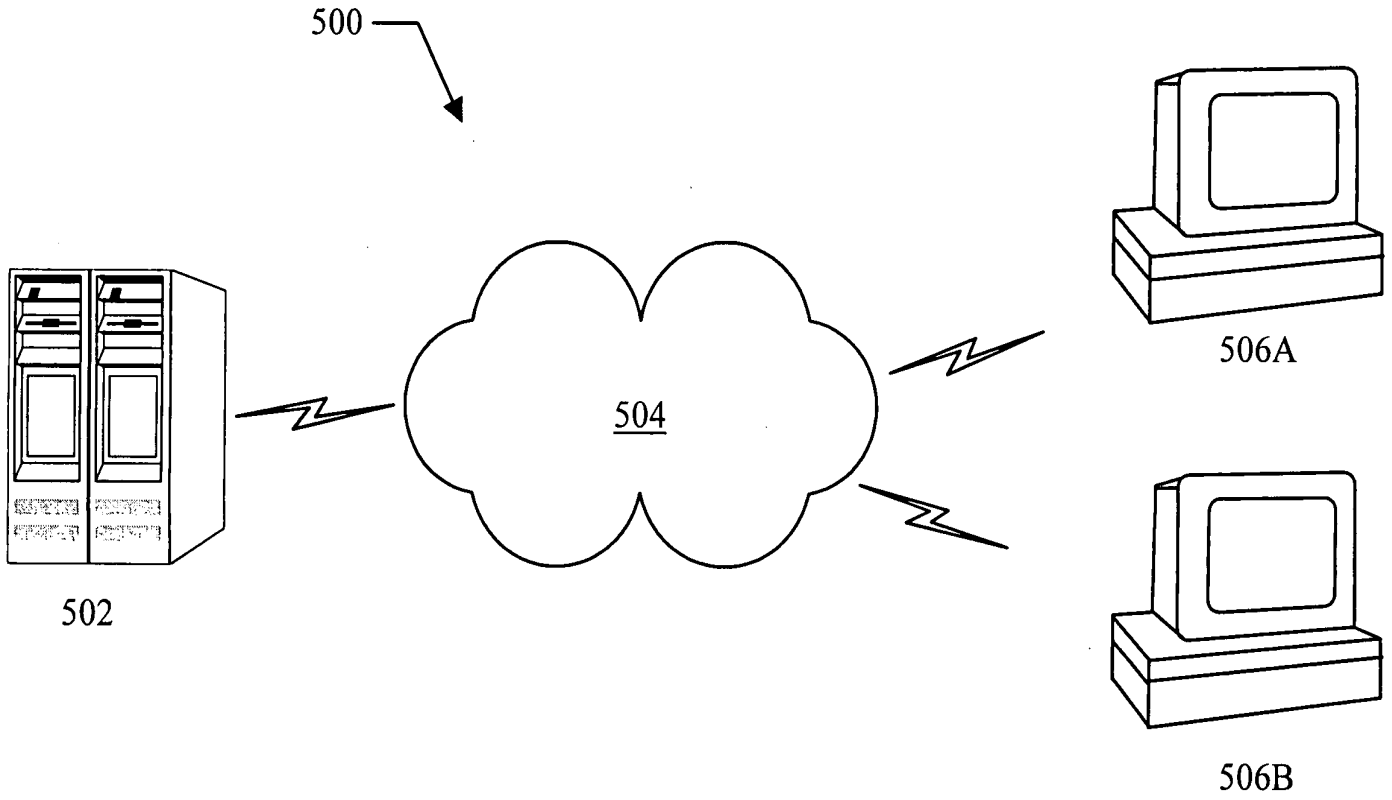


FIG. 20

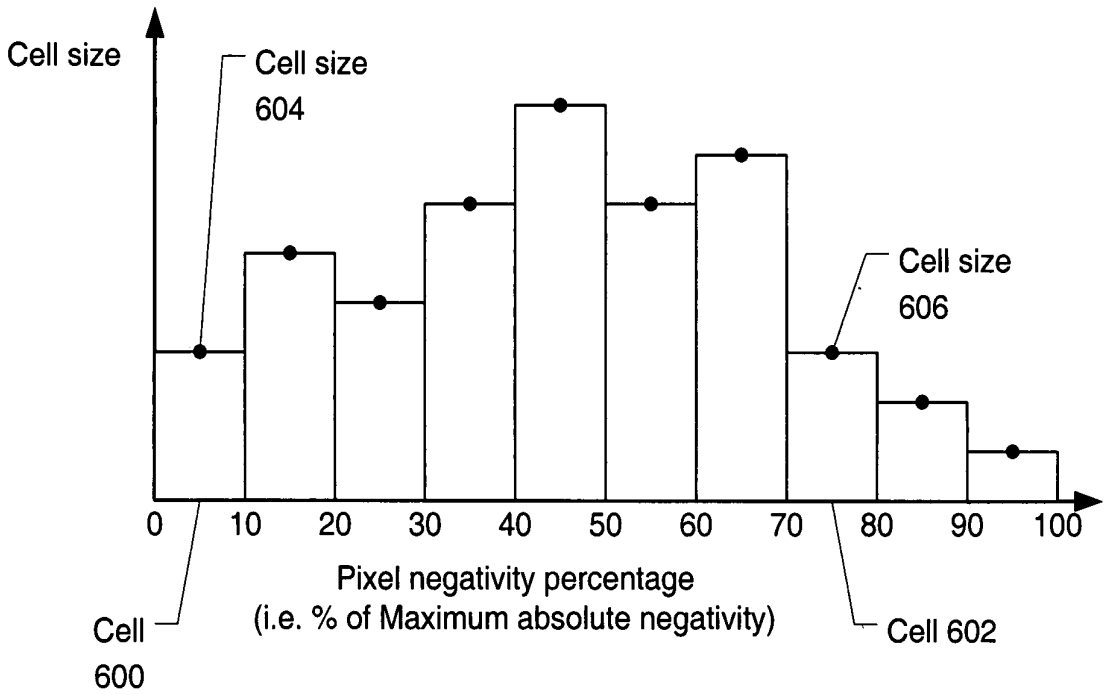
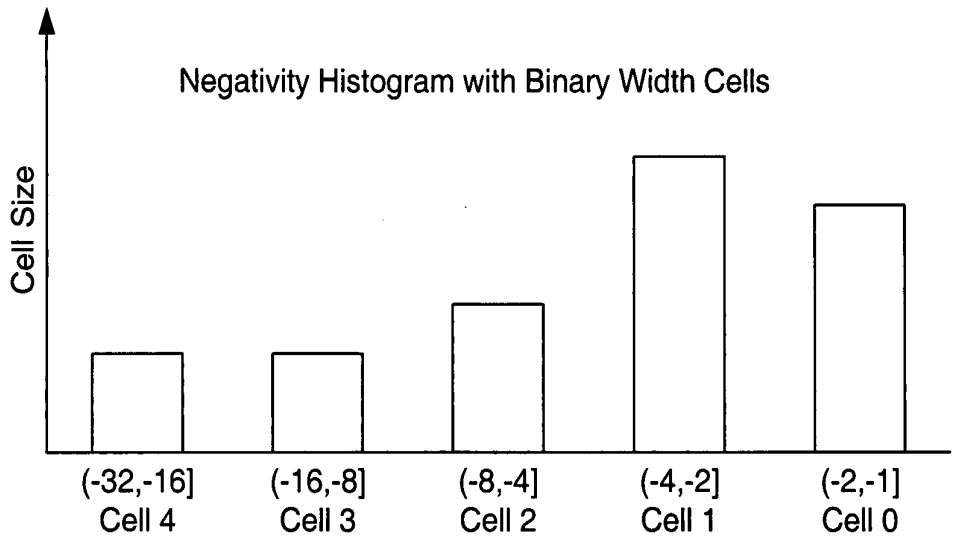

Cell size
Cell size
604
Cell size
606
0
10
20
30
40
50
60
70
80
90
100
Pixel negativity percentage
(i.e. % of Maximum absolute negativity)
Cell
600
Cell 602

Figure 21

SOCIETY ESTABLISHED



Each Cell defined by a ranges of pixel negativity values of the form (A,B]

Fig. 22

Fig. 23A Truncated Sinc Filter

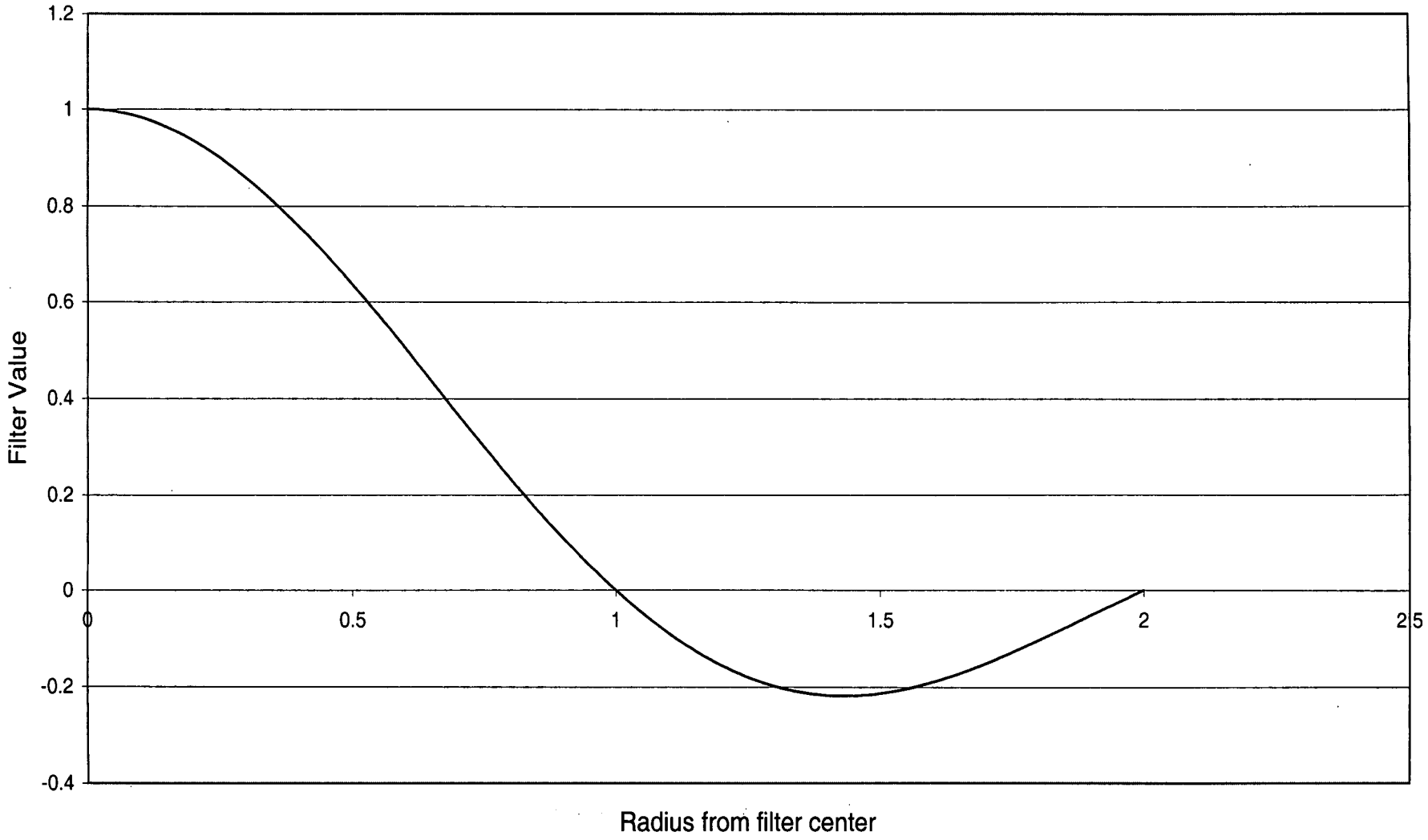


Fig. 23B Catmull-Rom Filter

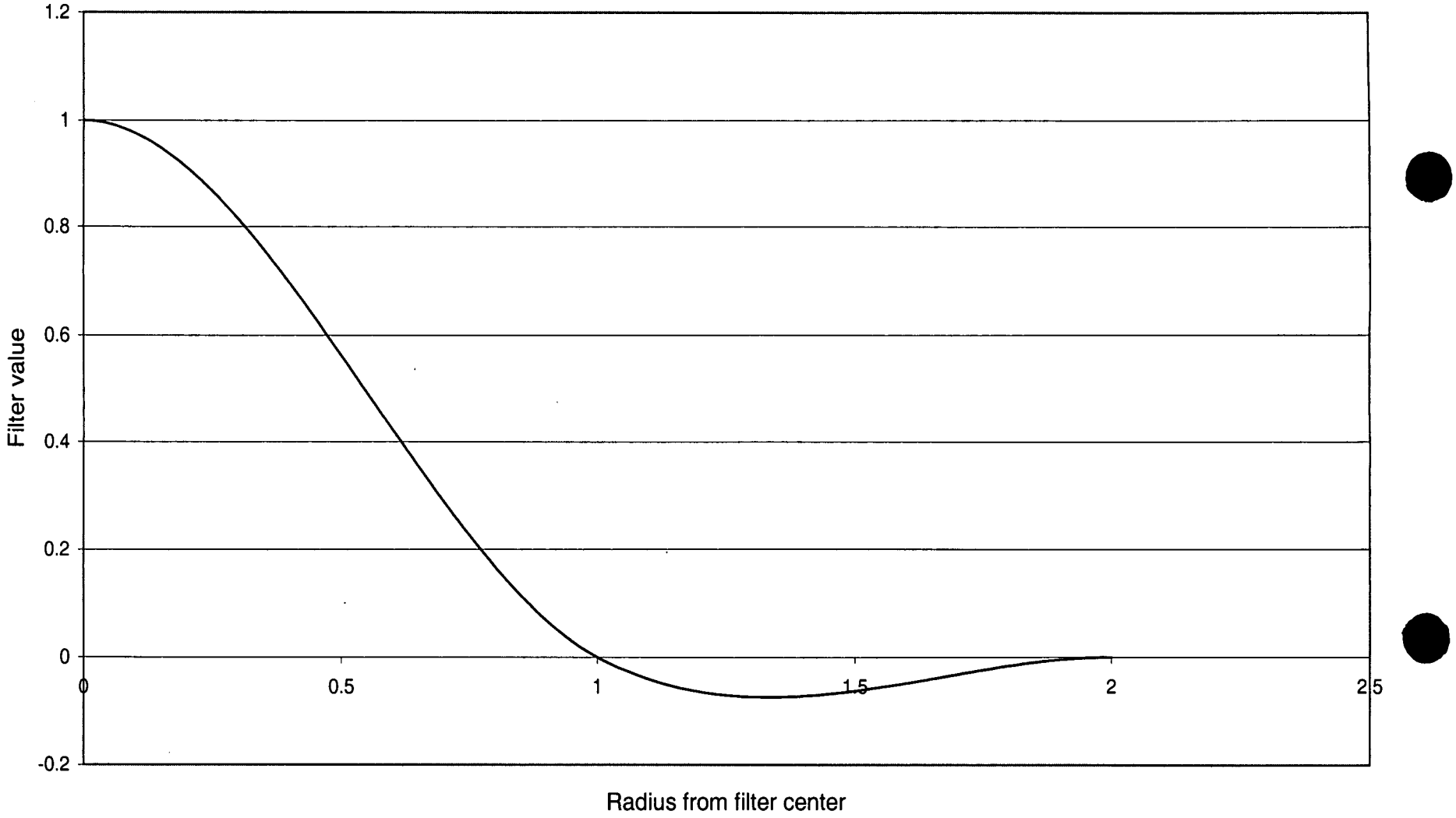
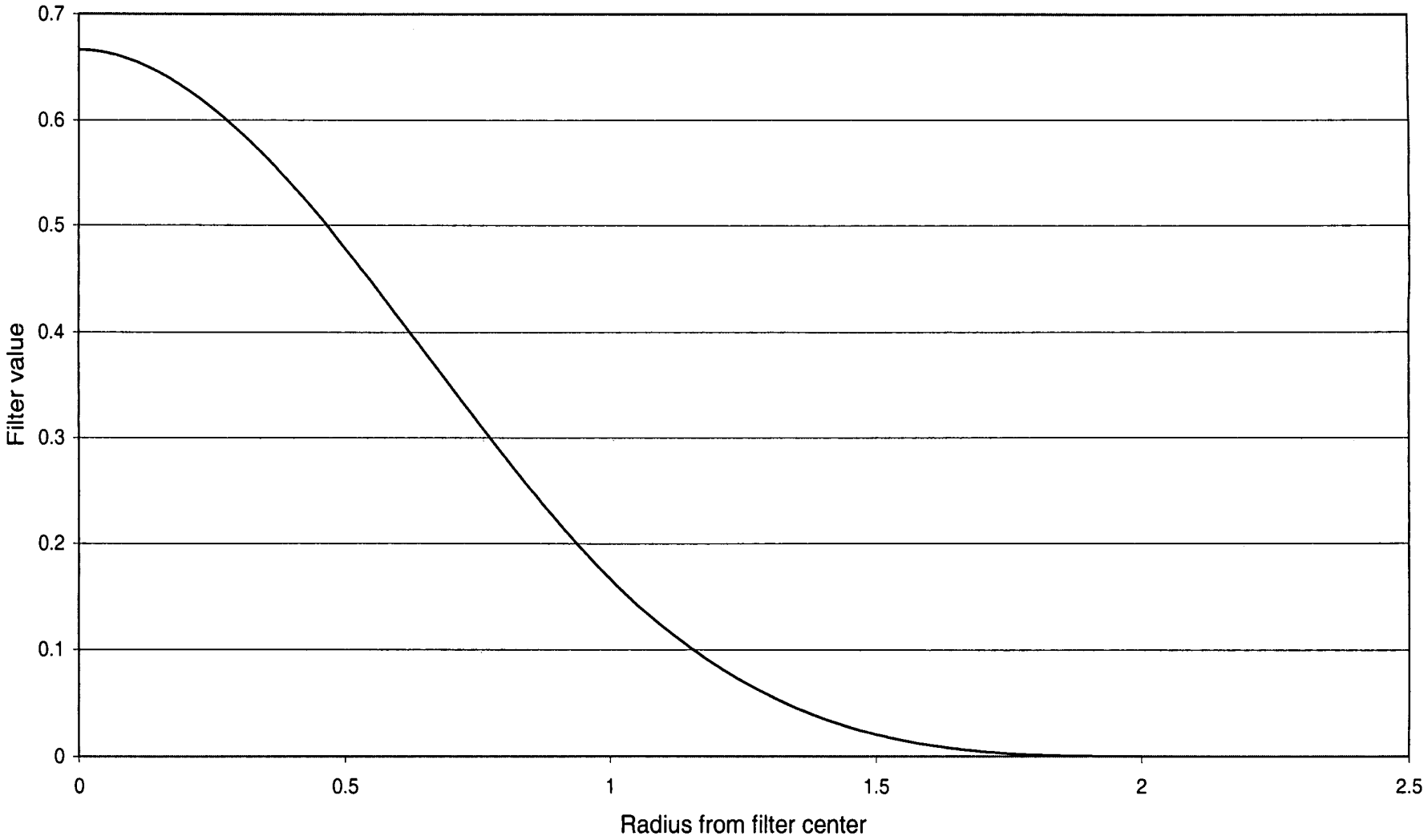


Fig. 23C Cubic B-Spline



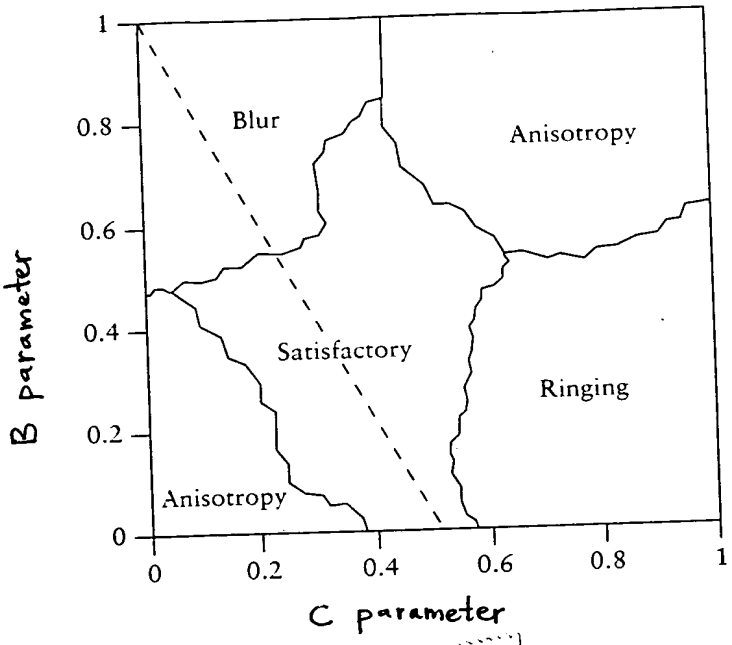

1
0.8
0.6
0.4
0.2
0
B parameter
Blur
Anisotropy
Satisfactory
Ringing
Anisotropy
0
0.2
0.4
0.6
0.8
1
C parameter

Fig. 23D

Fig. 23E Cardinal cublic spline,
i.e. Mitchell-Netravali filter (0,1)

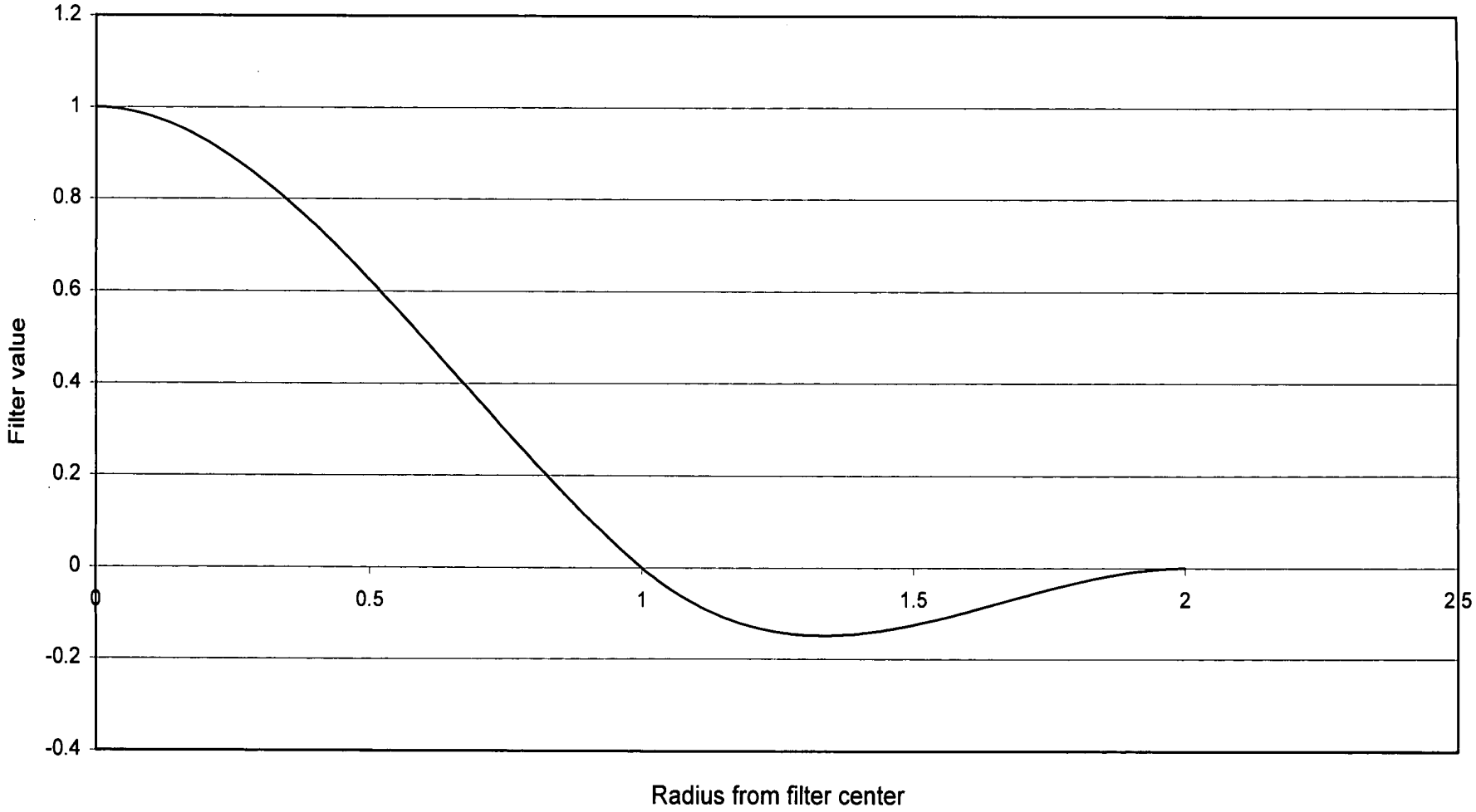
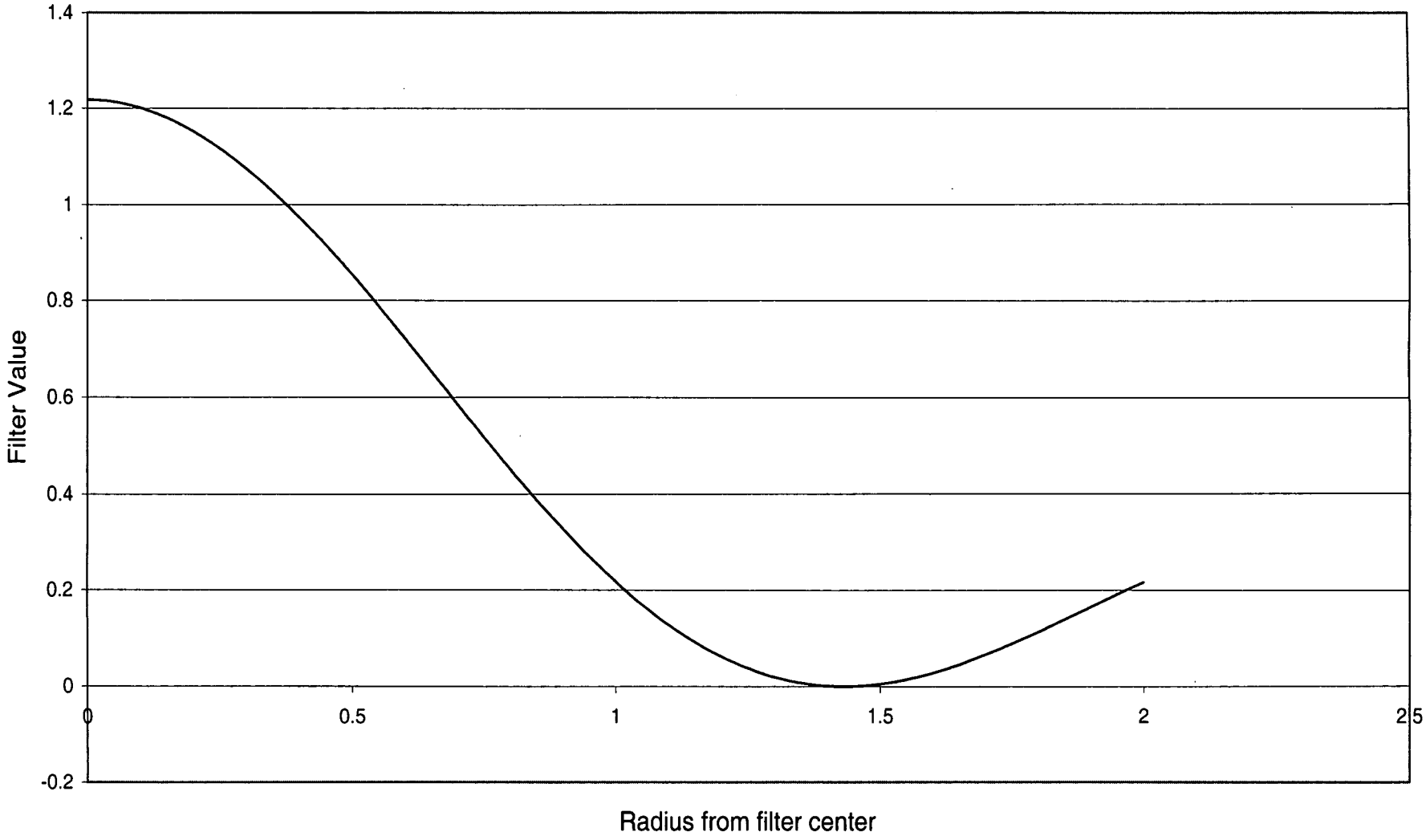


Fig. 24 Upward Shifted and Truncated Sinc Filter



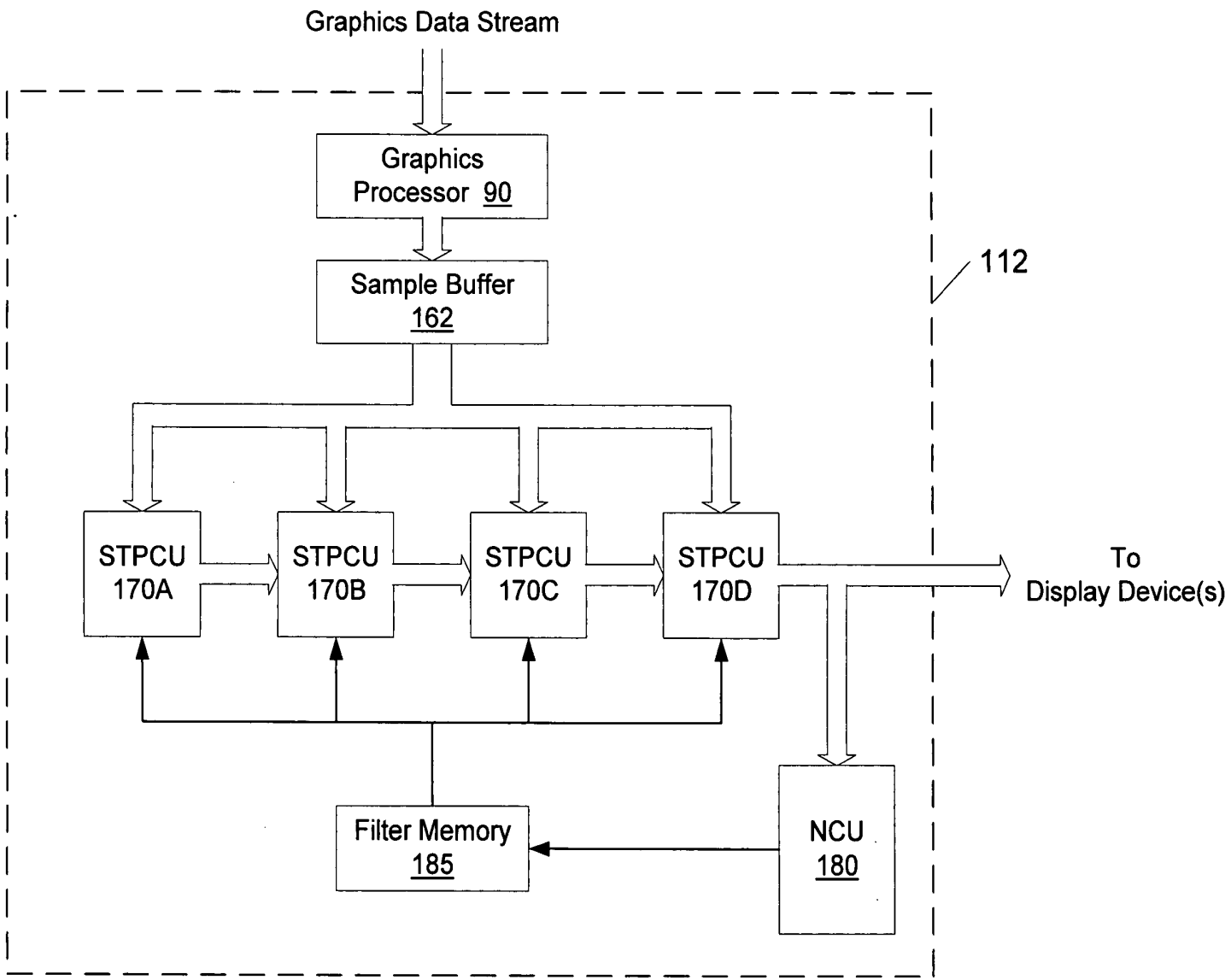

Graphics Data Stream
Graphics Processor 90
Sample Buffer 162
112
STPCU 170A
STPCU 170B
STPCU 170C
STPCU 170D
To Display Device(s)
Filter Memory 185
NCU 180

Fig. 25

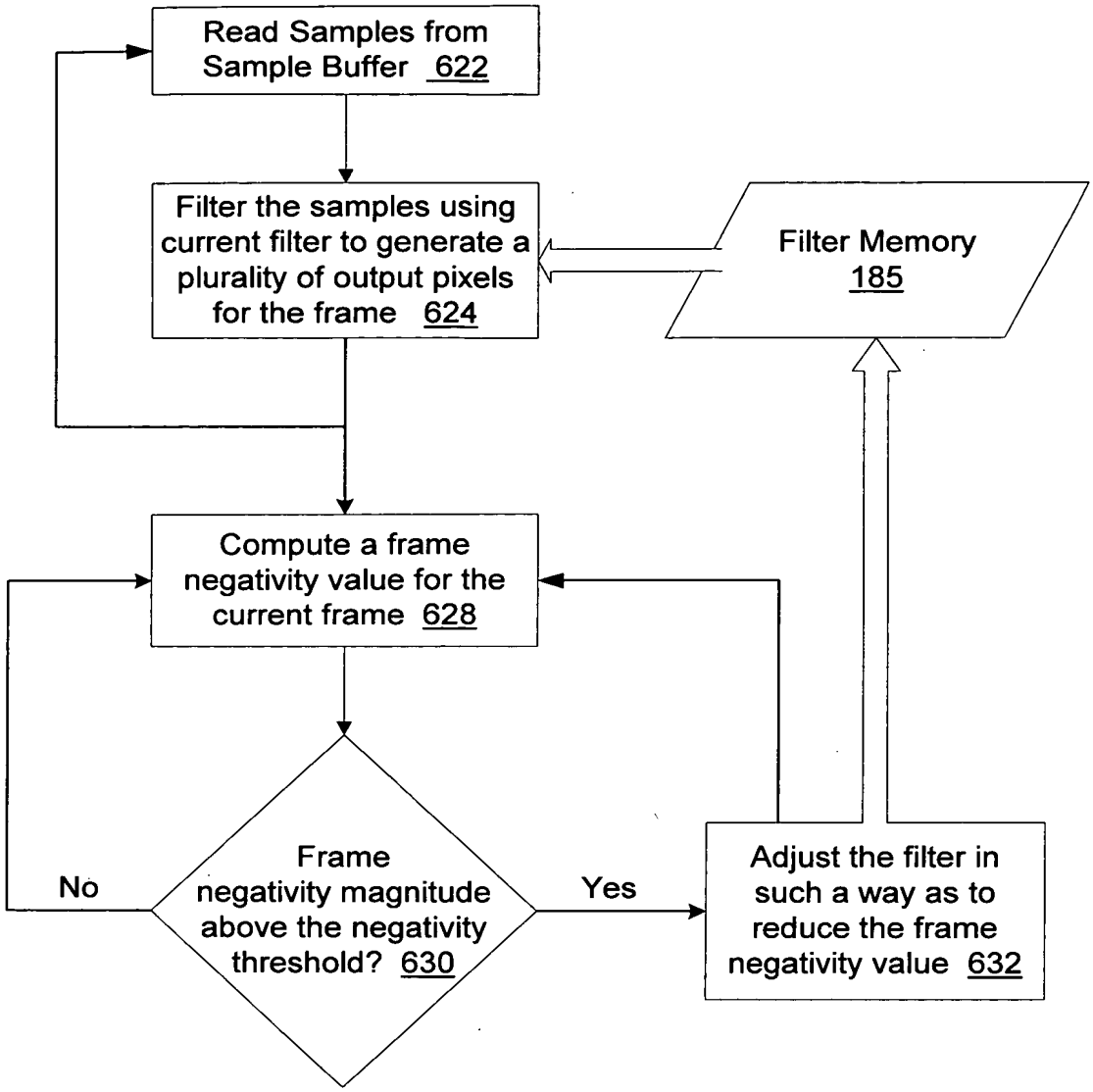

Read Samples from Sample Buffer 622
Filter the samples using current filter to generate a plurality of output pixels for the frame 624
Filter Memory 185
Compute a frame negativity value for the current frame 628
Frame negativity magnitude above the negativity threshold? 630
No
Yes
Adjust the filter in such a way as to reduce the frame negativity value 632

Fig. 26

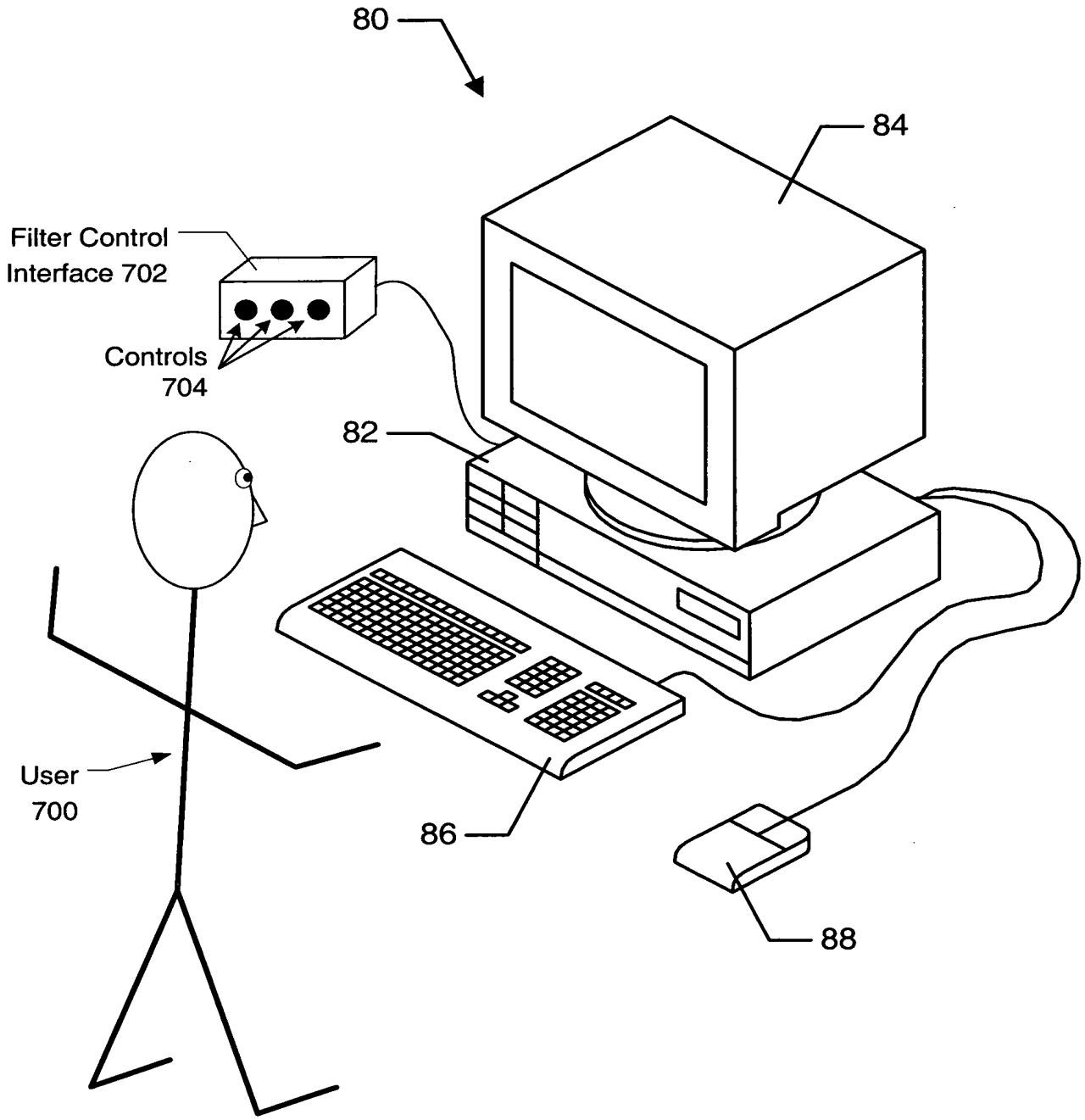

80
84
Filter Control
Interface 702
Controls
704
82
User
700
86
88

Fig. 27

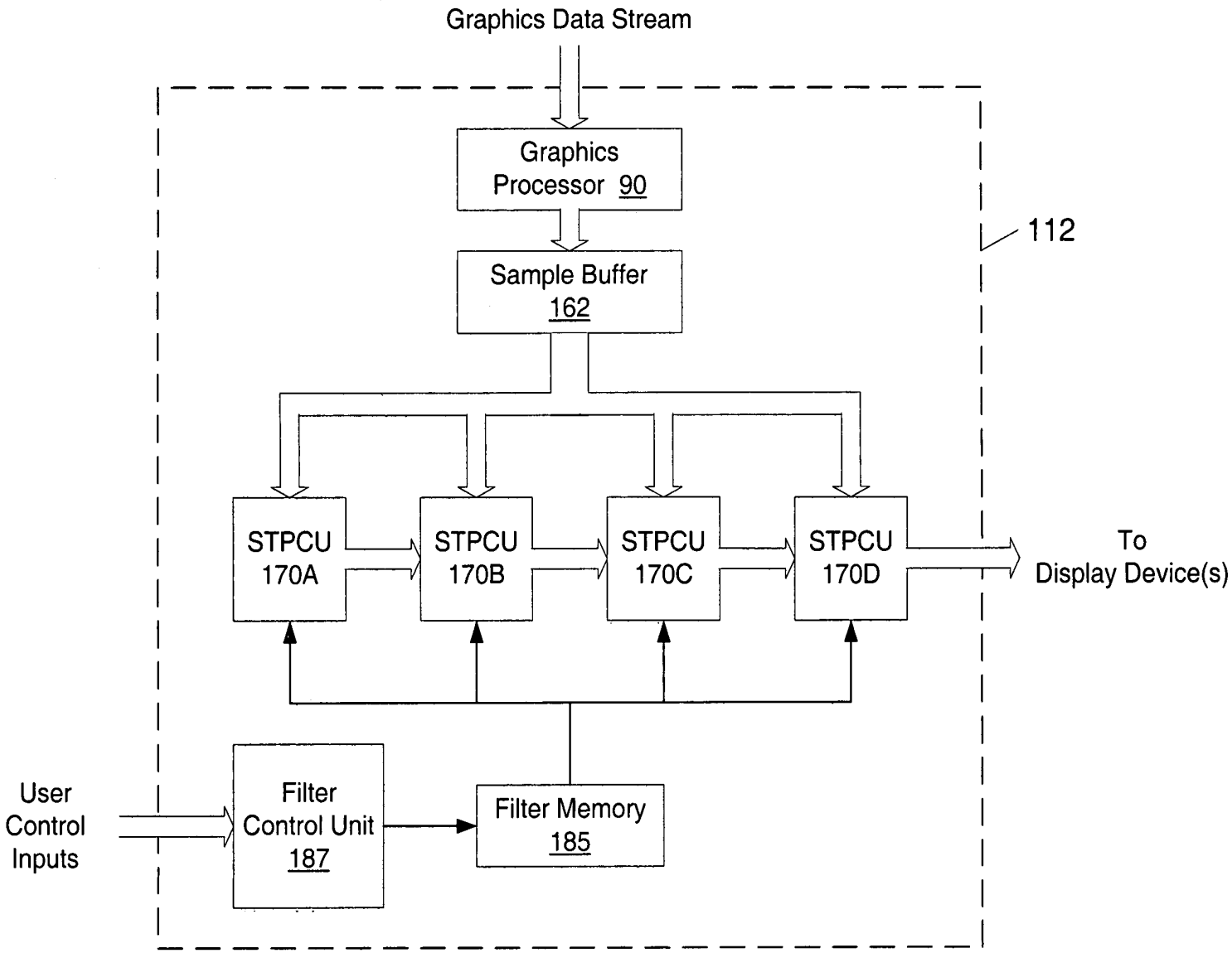

Graphics Data Stream
Graphics Processor 90
112
Sample Buffer 162
STPCU 170A
STPCU 170B
STPCU 170C
STPCU 170D
To Display Device(s)
User Control Inputs
Filter Control Unit 187
Filter Memory 185

Fig. 28

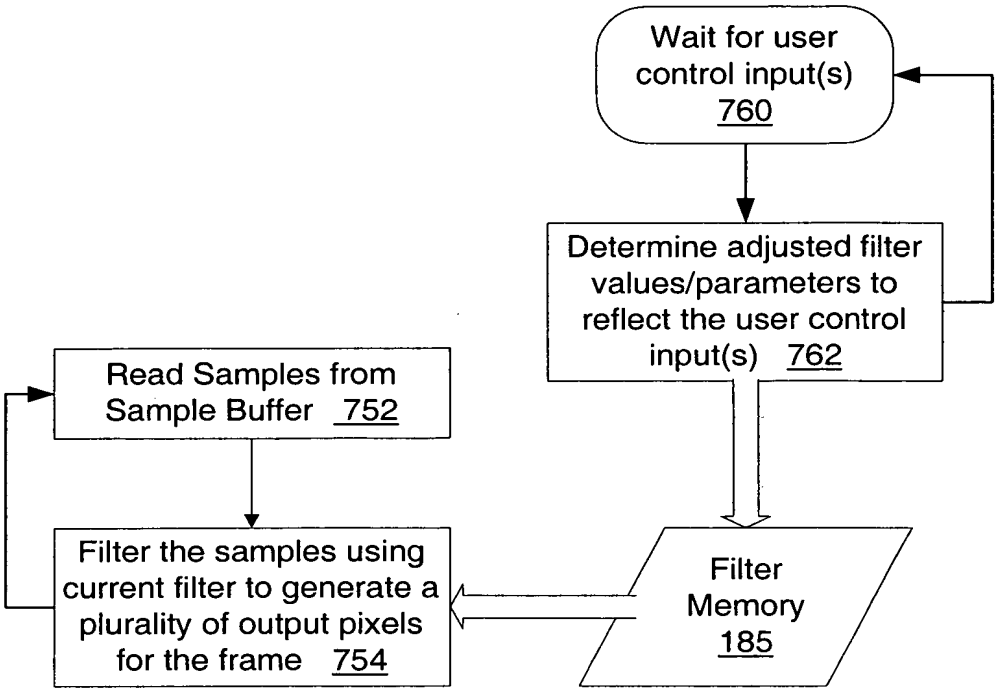

Wait for user control input(s) 760
Determine adjusted filter values/parameters to reflect the user control input(s) 762
Read Samples from Sample Buffer 752
Filter the samples using current filter to generate a plurality of output pixels for the frame 754
Filter Memory 185

Fig. 29

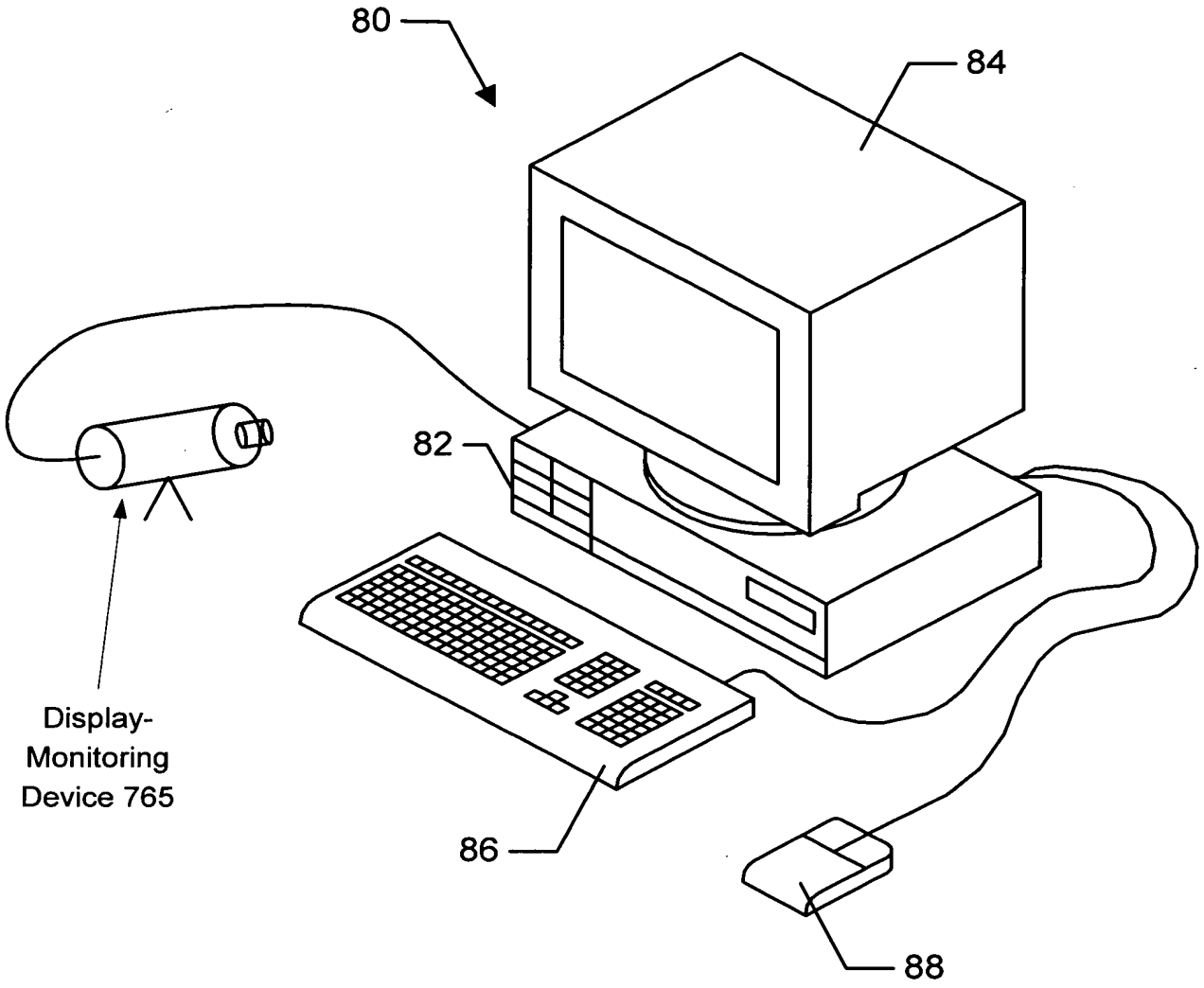


Figure 30

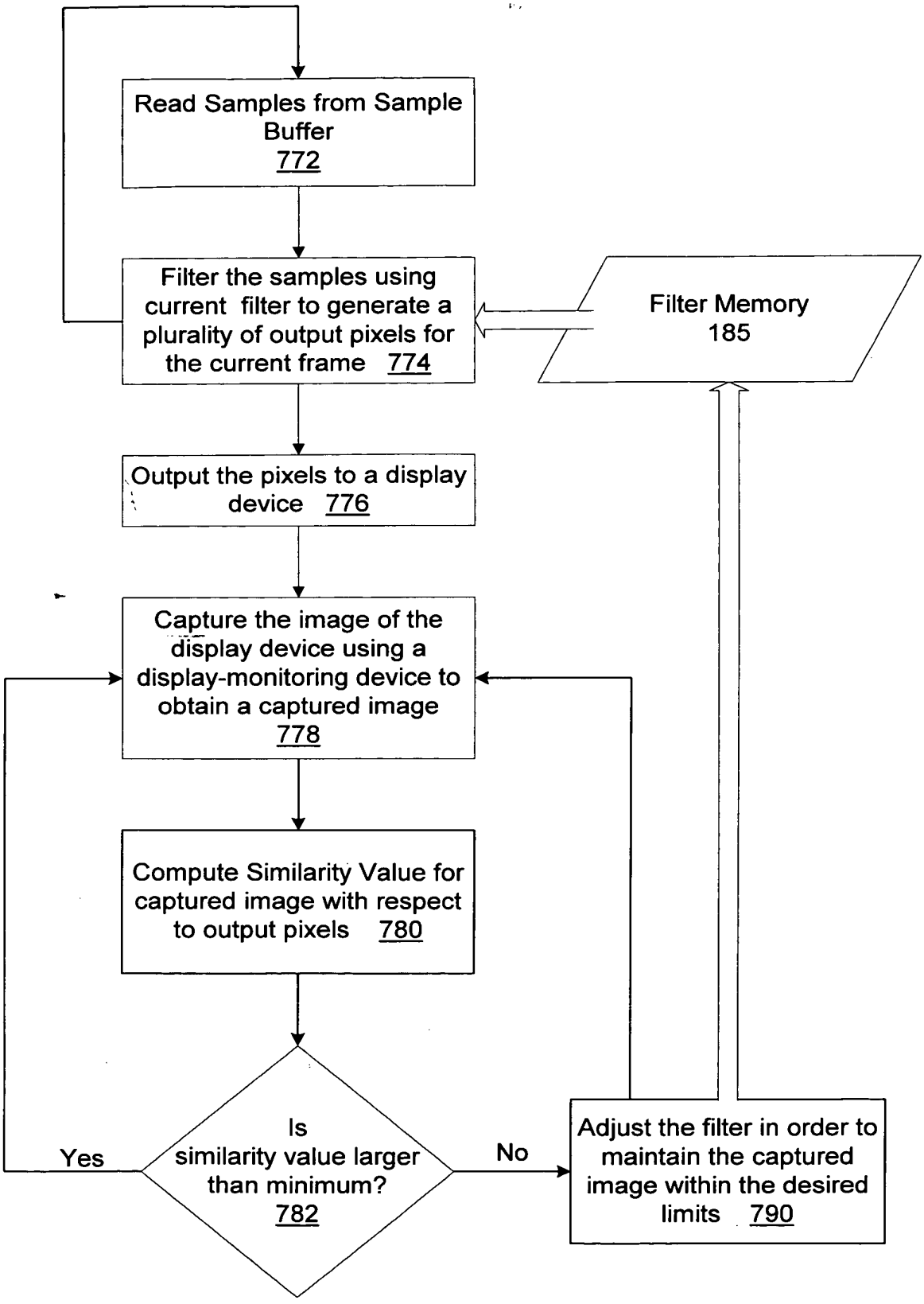

Read Samples from Sample Buffer 772
Filter the samples using current filter to generate a plurality of output pixels for the current frame 774
Filter Memory 185
Output the pixels to a display device 776
Capture the image of the display device using a display-monitoring device to obtain a captured image 778
Compute Similarity Value for captured image with respect to output pixels 780
Is similarity value larger than minimum? 782
Yes
No
Adjust the filter in order to maintain the captured image within the desired limits 790

Fig. 31